General Specifications

Item	Specification
Lubricants and Sealants	
Silicone Gasket and Sealant F7AZ-19554-EA	WSE-M4G323-A4
Premium Engine Coolant VC-4A, VC-5 in Oregon, CXC-10 in Canada	ESE-M97B44-A
Super Premium 5W-20 Motor Oil XO-5W20-QSP	WSS-M2C153-H
Threadlock 262 E2FZ-19554-B	WSK-M2G351-A6
Metal Surface Cleaner F4AZ-19A536-RA or equivalent	WSE-M5B392-A
Engine	
Displacement	4.6L (2V) (281 CID)
Number of cylinders	8
Bore	90.2 mm (3.55 in)
Stroke	90.0 mm (3.54 in)
Firing order	1-3-7-2-6-5-4-8
Oil pressure (hot 1,500 rpm)	138-310 kPa (20-45 psi)
Oil capacity	6.25 ± 0.25 quarts [a]
Compression ratio	9.37:1 (+0.61/-0.46)
Cylinder Head and Valve Train	
Combustion chamber volume	43.9 ± 1.5 cm^3
Valve arrangement (front to rear) — LH [b]	E-I-E-I-E-I-E-I
Valve arrangement (front to rear) — RH [b]	I-E-I-E-I-E-I-E
Valve guide bore diameter	7.015-7.044 mm (0.2762-0.2773 in)
Valve stem diameter	6.975-6.995 mm (0.2754-0.2746 in)
Valve stem-to-guide clearance — intake	0.020-0.069 mm (0.00078-0.00272 in)
Valve stem-to-guide clearance — exhaust	0.046-0.095 mm (0.0018-0.0037 in)
Valve head diameter — intake	44.37-44.63 mm (1.75-1.76 in)
Valve head diameter — exhaust	35.88-36.14 mm (1.41-1.43 in)
Valve face runout	0.05 mm (0.002 in)
Valve face angle	45.5 degrees
Valve seat width	1.3-1.5 mm (0.051-0.060 in)
Valve seat runout (T.I.R.)	Recommended 0.025 mm (0.001 in) max. 0.050 mm (0.002 in)
Valve seat angle	45 degrees
Valve spring free length (approx.)	51.77-54.97 mm (2.04-2.16 in)
Valve spring squareness	2 degrees
Valve spring compression pressure	720.0-800.0 N @ 28.80 mm (161.9 lb @ 1.13 in)

Valve spring installed height	42.3-42.9 mm (1.67-1.69 in)
Valve spring installed pressure	283.0-321.0 N @ 42.56 mm (63.61 lb @ 1.68 in)
Roller follower ratio — intake	2.02:1
Roller follower ratio — exhaust	2.03:1
Hydraulic Lash Adjuster	
Diameter	16.000-15.988 mm (0.6299-0.6294 in)
Clearance-to-bore	0.018-0.069 mm (0.0007-0.0027 in)
Service limit	15.988 mm
Hydraulic leakdown rate [c]	5-25 seconds
Collapsed lash adjuster gap — desired	0.45-0.85 mm (0.02-0.03 in)
Camshaft	
Theoretical valve lift @ 0 lash — intake	13.00 mm (0.51 in)
Theoretical valve lift @ 0 lash — exhaust	13.75 mm (0.54 in)
Lobe lift — intake	7.11038 mm (0.28 in)
Lobe lift — exhaust	7.4794 mm (0.30 in)
Allowable lobe lift loss	0 mm (0.0 in)
Journal diameter	26.962-26.936 mm (1.0615-1.0605 in)
Camshaft journal bore inside diameter	27.012-26.987 mm (1.0635-1.0625 in)
Camshaft journal-to-bearing clearance	0.025-0.076 mm (0.00098-0.002992 in)
Camshaft journal-to-bearing clearance — service limit	0.100 mm (0.003937 in) max.
Runout — Front and rear journals	0.03 mm (0.001 in)
Runout — four inner journals	0.09 mm (0.003 in)
End play	0.027-0.190 mm (0.001-0.007 in)
End play — service limit	0.190 mm (0.007480 in)
Cylinder Block	
Cylinder bore diameter	31 mm (1.24 in) from top of block red — 90.200-90.210 blue — 90.210-90.220 yellow — 90.220-90.230
Cylinder bore maximum taper	0.70 mm (0.027559 in)
Cylinder bore maximum out-of-round — limit	0.20 mm (0.007874 in)
Cylinder bore maximum out-of-round — service limit	0.70 mm (0.027559 in)
Main bearing bore inside diameter	72.400-72.424 mm (2.8504-2.8513 in)
Crankshaft	
Main bearing journal diameter	67.482-67.504 mm (2.66-21.661 in)
Main bearing journal maximum taper	0.004 mm (0.0002 in)
Main bearing journal maximum out-of-round	0.05 mm (0.002 in)
Main bearing journal-to-cylinder block clearance — desired	0.025-0.044 mm (0.001-0.002 in)
Main bearing journal-to-cylinder block clearance — allowable	0.025-0.050 mm (0.00098-0.00197 in)
Connecting rod journal diameter	52.983-53.003 mm (2.085941-2.086728 in)

Connecting rod journal maximum taper	0.004 mm (0.0002 in)
Connecting rod journal maximum out-of-round	0.05 mm (0.002 in)
Crankshaft maximum end play	0.075-0.377 mm (0.003-0.015 in)
Piston and Connecting Rod	
Piston diameter — code red 1 [d]	90.185-90.205 mm (3.55-3.551 in)
Piston diameter — code blue 2 [d]	90.195-90.215 mm (3.55-3.551 in)
Piston diameter — code yellow 3 [d]	90.205-90.225 mm (3.551-3.552 in)
Piston-to-cylinder bore clearance	-0.005-0.025 mm (-0.002/+0.001 in)
Piston ring end gap — compression (top) [e]	0.130-0.280 mm (0.005-0.011 in)
Piston ring end gap — compression (bottom) [e]	0.300-0.550 mm (0.0018-0.0022 in)
Piston ring end gap — oil ring (steel rail) [e]	0.150-0.650 mm (0.006-0.0256 in)
Piston ring groove width — compression (top)	1.530-1.550 mm (0.06-0.061 in)
Piston ring groove width — compression (bottom)	1.520-1.540 mm (0.06-0.061 in)
Piston ring groove width — oil ring	3.030-3.050 mm (0.12-0.12 in)
Piston ring width — compression (top)	1.480-1.500 mm (0.058-0.059 in)
Piston ring width — compression (bottom)	1.470-1.490 mm (0.0587-0.0586 in)
Piston ring-to-groove clearance — compression (top)	0.050-0.090 mm (0.002-0.004 in)
Piston ring-to-groove clearance — compression (bottom)	0.030-0.080 mm (0.00118-0.00315 in)
Piston ring-to-groove clearance — oil ring	Snug fit
Piston pin bore diameter [f]	21.008-22.014 mm (0.866-0.867 in)
Piston pin diameter	22.0010-22.0030 mm (0.87-0.871 in)
Piston pin length	61.601-62.030 mm (2.42523-2.44212 in)
Piston pin-to-piston fit	-0.005/+0.0135 mm (-0.0002/+0.0005 in)
Piston-to-connecting rod clearance — standard	0.009-0.0235 mm (0.0004-0.00092 in)
Piston-to-connecting rod clearance — service limit	0.035 mm (0.001378 in)
Connecting rod-to-pin clearance	0.009-0.023 mm (0.0004-0.0009 in)
Connecting rod pin bore diameter	22.012-22.024 mm (0.86661-0.86708 in)
Connecting rod length (center-to-center)	150.7 mm (5.933 in)
Connecting rod maximum allowed bend [g]	0.038 per 25 mm (0.00150 per 0.9843 in)
Connecting rod maximum allowed twist [c]	0.050 per 25 mm (0.00197 per 0.9843 in)
Connecting rod bearing bore diameter	56.866-56.886 mm (2.23881-2.23960 in)
Connecting rod bearing-to-crankshaft clearance	0.027-0.069 mm (0.0010629-0.0027165 in)
Connecting rod side clearance — standard	0.125-0.475 mm (0.005-0.019 in)
Connecting rod side clearance — service limit	0.50 mm (0.01969 in) max.

[a] With installation of a new filter.
[b] Distance front edge of bearing is installed below front face of cylinder block.
[c] Time necessary for plunger to leak down 1.6 mm of travel with 222 N force and leak down fluid in tappet.
[d] Measured at 31.5 mm from top of block. Measured at 43 mm from top of piston, at 90 degrees to the piston pin.

[e] Specification in 90.200 mm diameter gauge.
[f] If applicable, measured vertically, +0.030-0.050 mm (0.001-0.002 inch) measured horizontally (oval pin bore).
[g] Pin bore and crank bearing bore must be parallel and in same vertical plane within the specified total difference when measured at the ends of a 203 mm bar, 101.5 mm on each side of rod centerline.

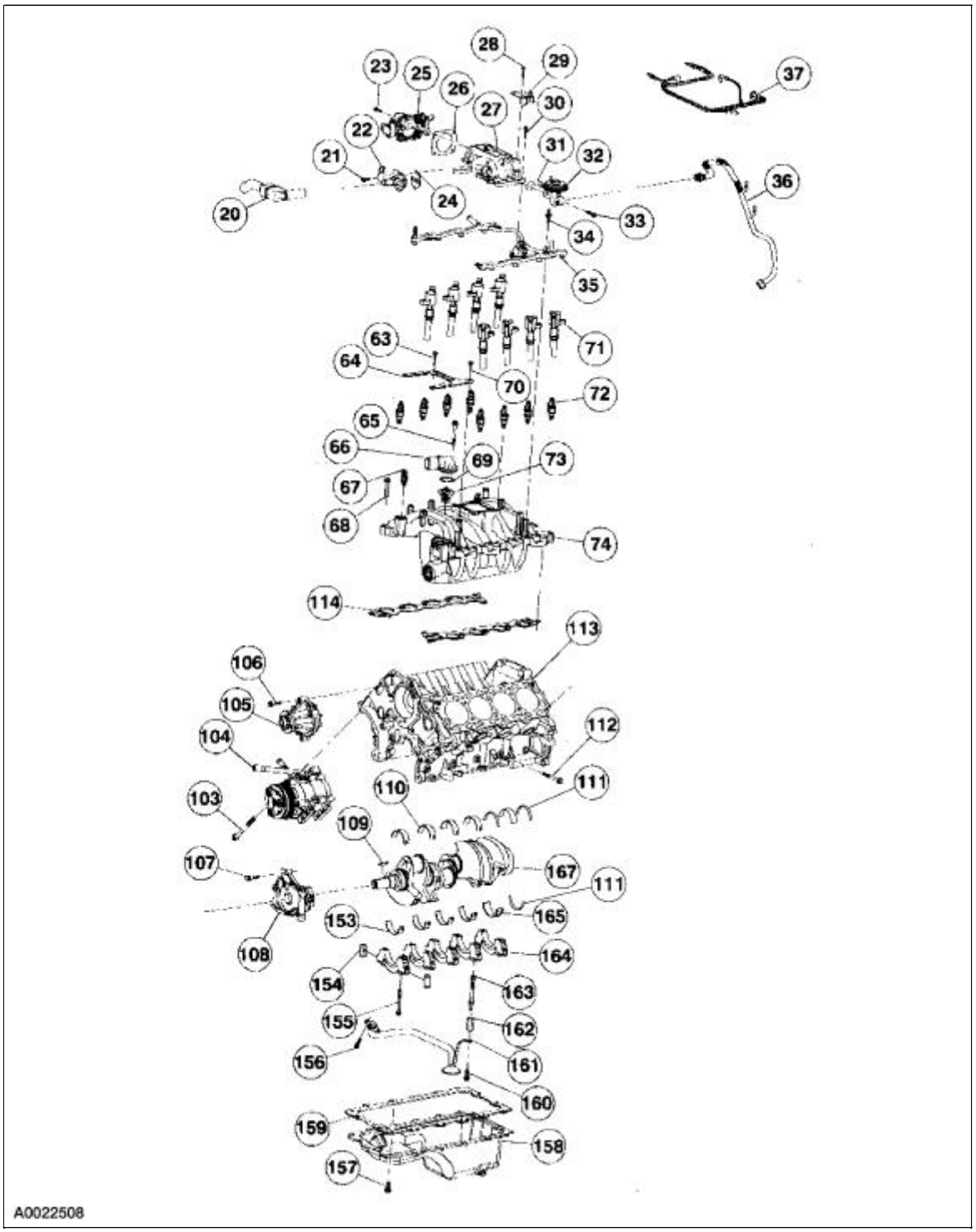
Torque Specifications

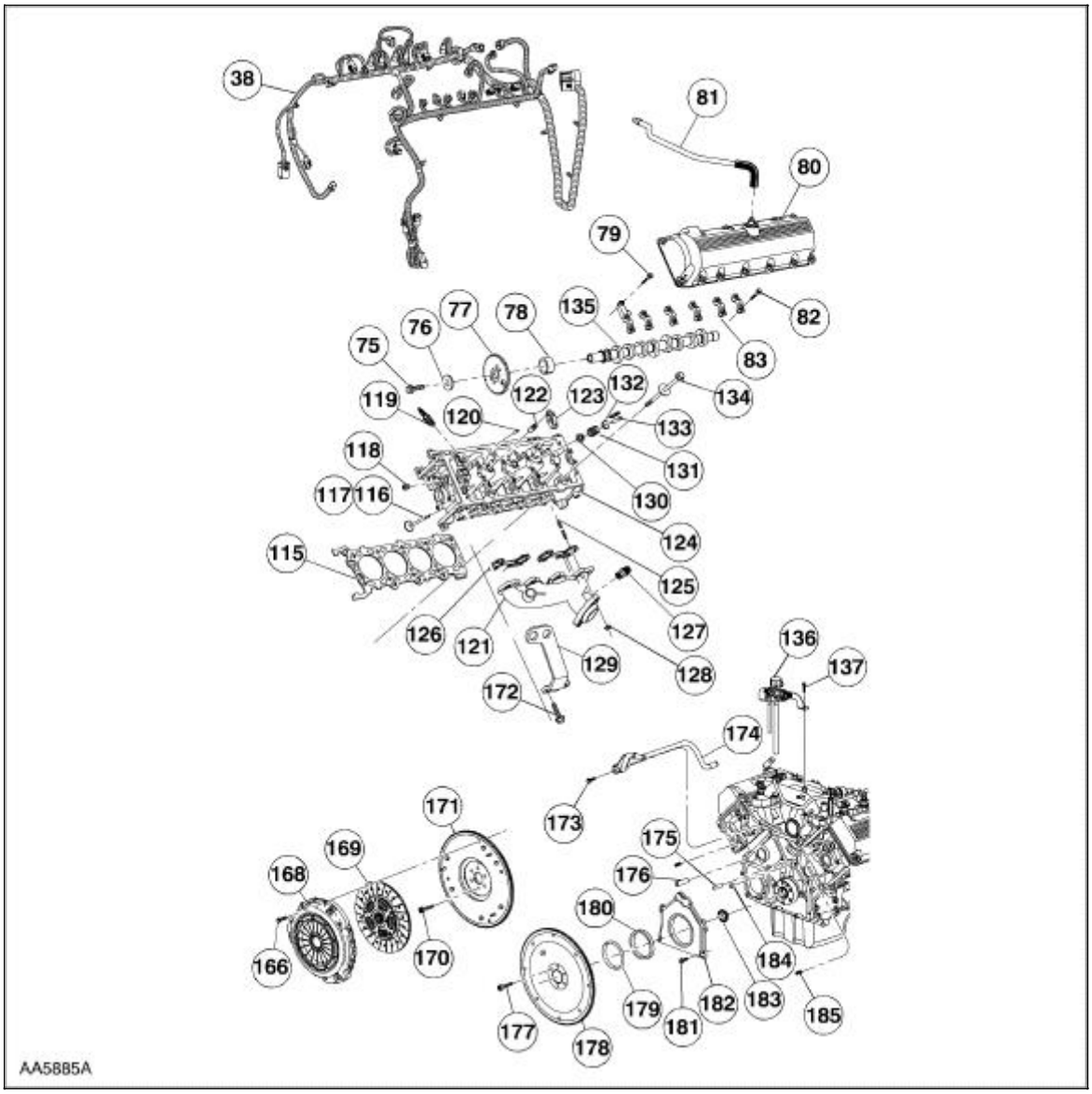
Description	Nm	lb-ft	lb-in
Main bearing cap adjusting bolts [a]	—	—	—
EGR sensor bracket	10	—	89
Belt idler pulley	25	18	—
Oil filter	15	11	—
Oil filter adapter insert	58	43	—
Camshaft sprocket bolt [a]	—	—	—
Connecting rod bolt [a]	—	—	—
Engine mount nuts	150	111	—
Engine mount-to-cylinder block bolts	70	52	—
Exhaust manifolds [a]	—	—	—
Engine front cover bolts [a]	—	—	—
Drive belt tensioner bolts	25	18	—
A/C muffler	20	15	—
Battery cable support brackets	20	15	—
Cylinder head bolt [a]	—	—	—
Pulley-to-crankshaft bolt [a]	—	—	—
EGR valve to intake manifold	25	18	—
EGR valve tube to exhaust manifold fittings	40	30	—
Intake manifold-to-cylinder head bolt	25	18	—
Main bearing cap bolt [a]	—	—	—
Oil filter adapter bolts	25	18	—
Oil level indicator tube bolt	10	—	89
Oil pump screen cover and tube-to-oil pump bolt	10	—	89
Oil pan-to-cylinder block bolt [a]	—	—	—
Flywheel	80	59	
Oil pan-to-engine front cover bolts [a]	—	—	—
Oil pump-to-cylinder block bolt	10	—	89
Oil pump screen cover and tube-to-main bearing cap stud spacer bolt	25	18	—
Water pump pulley bolts	25	18	—
Cam cover bolt [a]	—	—	—
Water pump-to-cylinder block bolt	25	18	—
Water bypass tube	25	18	—
EGR tube nuts (2 req'd)	40	30	—
Power steering pump to engine	25	18	—

Power steering reservoir bolts	10	—	89
Water outlet connector bolts	25	18	—
Camshaft cap cluster to cylinder head bolts	10	—	89
Torque converter nuts	25	18	—
Timing chain tensioner bolts	25	18	—
Transmission filler tube bolt	47	35	—
A/C compressor bolts	25	18	—
Ignition coil bolts	6	—	53
Generator brace bolts	10	—	89
Primary timing chain guide-to-engine bolts	10	—	89
Accelerator cable bracket bolts	10	—	89
Rear seal retainer bolts	10	—	89
Pressure plate bolts	2	—	47
Spark plugs	18	13	—
Crankshaft timing bolt sensor assembly	10	—	89
Camshaft timing bolt sensor assembly	10	—	89
Fuel rail studs	10	—	89
Engine coolant sensor	15	11	—
Exhaust manifold—stud to cylinder head	10-13	7-10	—
Throttle body adaptor bolts [a]	—	—	—
Throttle body bolts	10	—	89
Idle air control valve	10	—	89
RFI capacitor nut	10	—	89
Generator bolts	25	18	—
Oil pan drain plug	14	10	—
Water bypass tube bracket bolt	25	18	—
Subframe bolts	115	85	—
Battery lead to generator	10	—	89
EGR vacuum regulator solenoid bracket	10	—	89
Pipe plug—water drain	20	15	—
Screen and cover assembly to main bearing cap stud spacer	25	18	—
Wiring harness retainer nut	10	—	89
Oil pressure switch [a]	—	—	—
A/C muffler stud to cylinder head	10	—	89
EGR tube to exhaust manifold connector	50	37	—

[a] Refer to the procedure in this section.

Engine

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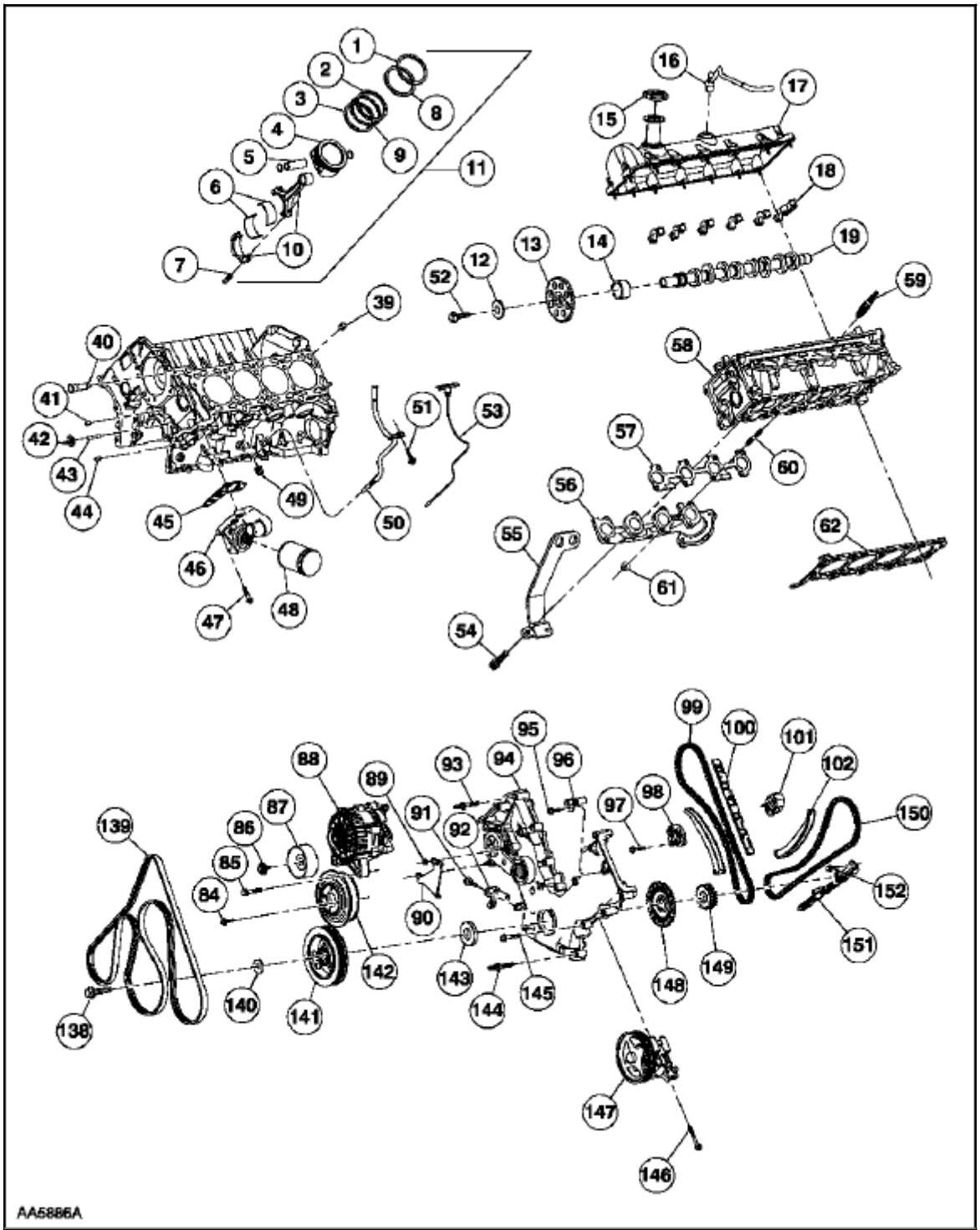

Item	Part Number	Description
1	6150	Piston ring
2	6159	Piston ring
3	6159	Piston ring
4	6110	Piston
5	6135	Piston pin
6	6211	Connecting rod bearing
7	6214	Connecting rod bolt
8	6152	Piston ring

9	6161	Piston ring
10	6200	Connecting rod assy.
11	6100	Piston and rod assy (8 req'd)
12	N806164	Washer
13	6256	Camshaft sprocket
14	6265	Camshaft sprocket spacer
15	6766	Oil filler cap
16	6C324	Crankcase vent connector and hose
17	6582	Valve cover
18	6B280	Camshaft bearing cap
19	6250	Camshaft
20	9H308	Idle air control valve inlet tube
21	N806155	Bolt (2 req'd)
22	9F715	Idle air control valve
23	N806154	Bolt (4 req'd)
24	9F670	Idle air control gasket
25	9E926	Throttle body
26	9E936	Throttle body gasket
27	9A589	Throttle body gasket
28	N807309	Bolt (3 req'd)
29	9728	Bracket
30	N806154	Bolt (5 req'd)
31	9D476	EGR valve gasket
32	9D460	EGR valve
33	W701625	Bolt (2 req'd)
34	N811017	Stud bolt (4 req'd)
35	9F792	Fuel injection supply manifold
36	9D477	EGR valve to exhaust manifold tube
37	9E498	Main emission vacuum control connector
38	12A522	Engine control sensor extension wire
39	N806459	Dowel (4 req'd)
40	8555	Water bypass tube
41	N646419	Dowel (2 req'd)
42	W623454	Washer (2 req'd)
43	N806040	Dowel (2 req'd)
44	N806007	Dowel (2 req'd)
45	6A636	Oil filter adapter gasket
46	6881	Oil filter adapter (manual transmission)
47	N806156	Bolt (4 req'd)
48	6714	Oil bypass filter
49	N87838	Dowel
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	6754	Oil level indicator tube
51	N806155	Bolt
52	N806139	Bolt
53	6750	Oil level dipstick
54	N811363	Bolt (2 req'd)
55	18198A	Engine lifting eye
56	9430	Exhaust manifold
57	9448	Exhaust manifold gasket
58	6049	Cylinder head, RH
59	12405	Spark plug
60	W701681	Stud (8 req'd)
61	W701706	Nut (8 req'd)
62	6051	Head gasket
63	N807071	Bolt
64	10153	Generator mounting bracket
65	N811011	Bolt (2 req'd)
66	8549	Water outlet connector
67	10884	Water temperature indicator sender unit
68	N808130	Bolt (9 req'd)
69	N806807	O-ring
70	N807309	Bolt (2 req'd)
71	12A366	Coil on plug (8 req'd)
72	9F593	Fuel injector
73	8575	Water thermostat
74	9424	Intake manifold
75	N806139	Bolt
76	N806164	Washer
77	6256	Camshaft sprocket
78	6265	Camshaft sprocket spacer
79	N807352	Bolt (4 req'd)
80	6A505	Valve cover
81	6758	Crankcase ventilation tube
82	N806070	Bolt (24 req'd)
83	6B280	Camshaft bearing cap
84	N806282	Bolt (4 req'd)
85	N807173	Bolt (2 req'd)
86	N808102	Bolt
87	19A216	Belt idler pulley
88	10300	Generator
89	N804178	Nut (2 req'd)
90	19A439	Bracket
91		

	N806155	Bolt (2 req'd)
92	6C315	Crankshaft position sensor
93	N806300	Stud bolt (5 req'd)
94	6C086	Engine front cover
95	N806155	Bolt
96	6B288	Camshaft position sensor
97	N606543	Bolt (4 req'd)
98	6L266	Timing chain tensioner
99	6268	Timing chain belt
100	6K297	Timing chain cover
101	6M269	Timing chain tensioner
102	6L253	Timing chain tensioner arm
103	N806184	Bolt (3 req'd)
104	19D629	A/C compressor
105	8501	Water pump
106	N806177	Bolt (4 req'd)
107	N806183	Bolt (4 req'd)
108	6621	Oil pump
109	N806201	Woodruff key
110	6333	Crankshaft main bearing (5 req'd)
111	6A341	Crankshaft thrust washer (3 req'd)
112	6C357	Crankshaft main bearing side bolt (10 req'd)
113	6010	Cylinder block
114	9439	Intake manifold gasket (2 req'd)
115	6083	Head gasket
116	6505	Exhaust valve (8 req'd)
117	6507	Intake valve (8 req'd)
118	87838	Pipe plug (8 req'd)
119	12405	Spark plug (8 req'd)
120	6F087	Dowel
121	9431	Exhaust manifold
122	6C501	Valve tappet (16 req'd)
123	6529	Rocker arm (16 req'd)
124	6049	Cylinder head, RH
125	W701681	Stud (8 req'd)
126	9Y431	Exhaust manifold gasket
127	9F485	EGR valve tube to manifold connector
128	W701706	Nut (8 req'd)
129	181198A	Engine lifting eye
130	6A517	Valve stem seal (16 req'd)
131	6513	Valve spring (16 req'd)
132		

	6514	Valve spring retainer (16 req'd)
133	6518	Valve spring retainer key (32 req'd)
134	6065	Cylinder head bolt (20 req'd)
135	6C255	Camshaft
136	9J434	EGR transducer
137	N807309	Bolt (2 req'd)
138	N806139	Bolt
139	8620	Drive belt
140	N806165	Washer
141	6316	Crankshaft pulley
142	8A528	Water pump pulley
143	6700	Crankshaft front seal
144	N808793	Stud bolt (2 req'd)
145	N806177	Bolt (6 req'd)
146	N806176	Bolt (3 req'd)
147	3A674	Power steering pump
148	12A227	Ignition pulse ring
149	6306	Crankshaft sprocket (2 req'd)
150	6268	Timing chain/belt
151	6K297	Timing chain guide
152	N804958	Bolt (4 req'd)
153	6A338	Crankshaft main bearing (4 req'd)
154	6A346	Crankshaft main bearing cap dowel pin (10 req'd)
155	6345	Crankshaft main bearing cap bolt (9 req'd)
156	N806155	Bolt (2 req'd)
157	W701240	Bolt (16 req'd)
158	6675	Oil pan
159	6710	Oil pan gasket
160	N605904	Bolt
161	6622	Oil pump screen cover and tube
162	N806180	Spacer
163	6K258	Crankshaft main bearing cap stud
164	6325	Main bearing cap (5 req'd)
165	6A339	Crankshaft thrust main bearing
166	N602549	Bolt
167	6303	Crankshaft
168	7563	Clutch pressure plate
169	7550	Clutch disc
170	N808139	Bolt (6 req'd)
171	6375	Flywheel (manual transmission)
172	N811363	Bolt (2 req'd)
173		

	N605919	Bolt
174	18663	Heater water tube
175	N806007	Dowel (2 req'd)
176	N807198	Dowel (2 req'd)
177	N806168	Bolt (6 req'd)
178	6375	Flywheel (automatic transmission)
179	6310	Crankshaft oil slinger
180	6701	Crankshaft rear oil seal
181	N806155	Bolt (6 req'd)
182	6K318	Crankshaft rear oil seal and retainer
183	7120	Transmission input shaft pilot bearing
184	N806435	Pipe plug
185	N87836	Dowel (2 req'd)

A modular engine is built around four modules:

- the intake module
- the cylinder head module (RH)
- the cylinder head module (LH)
- the lower engine module

While not all repairs can take advantage of the modular concept, most out-of-vehicle repairs benefit due to the reduction of necessary time and labor.

The basic engine components consist of the following:

- single overhead camshafts
- two valves per cylinder
- sequential multiport fuel injection (SFI)
- aluminum cylinder heads (6049)
- cast iron, 90-degree V-shaped cylinder block
- individual ignition coils for each spark plug
- composite-material intake manifold
- large-bore throttle body

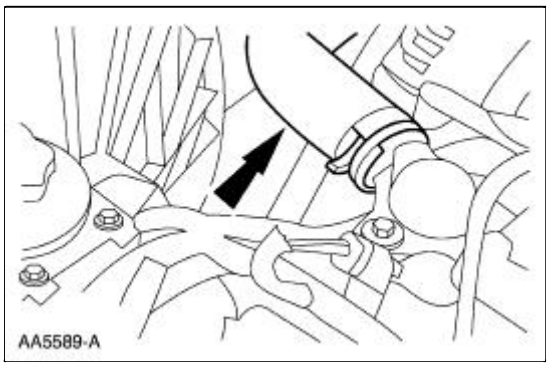
Engine

For basic mechanical concerns, refer to Section 303-00 . Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

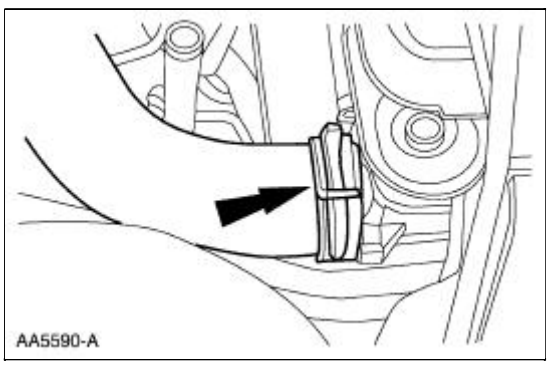
Intake Manifold

Removal

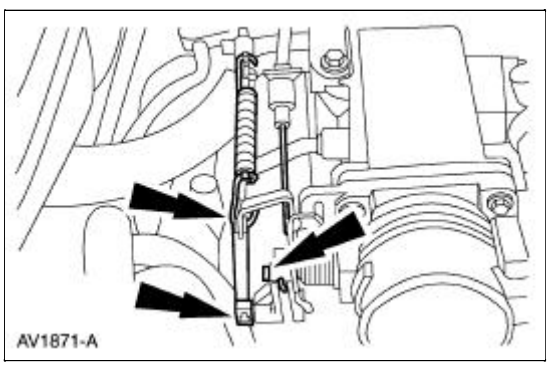
1. Drain the engine cooling system. For additional information, refer to Section 303-03A or Section 303-03B .
2. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .
3. Disconnect the fuel line. For additional information, refer to Section 310-00 .
4. Disconnect the upper radiator hose from the water outlet connector.



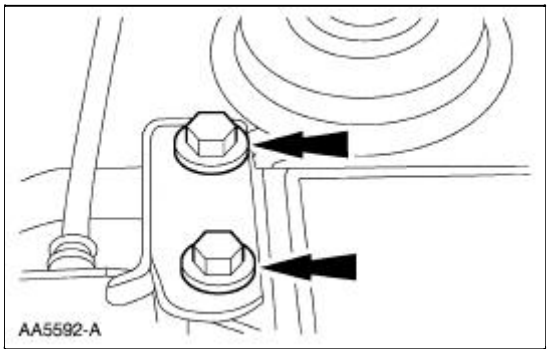
5. Disconnect and remove the upper radiator hose.



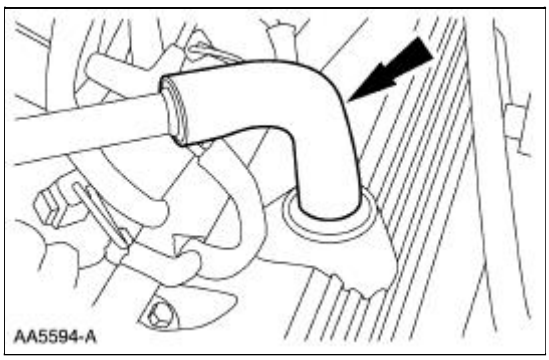
6. Disconnect the accelerator cable, speed control actuator cable and return spring.



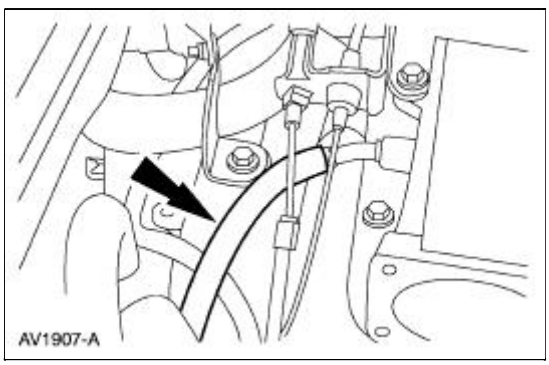
7. Remove the bolts and position the cables and bracket out of the way.



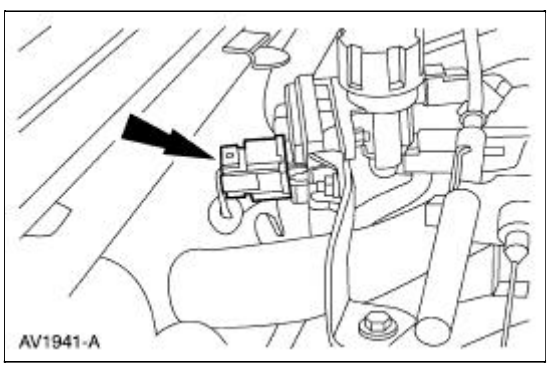
8. Remove the breather tube.



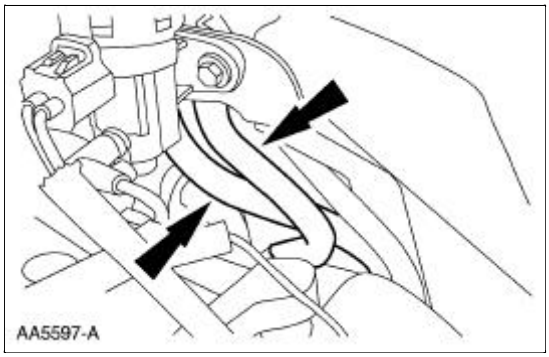
9. Disconnect the evaporative emissions return line.



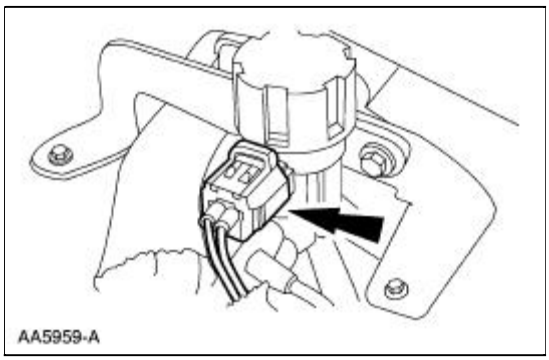
10. Disconnect the differential pressure feedback EGR electrical connector.



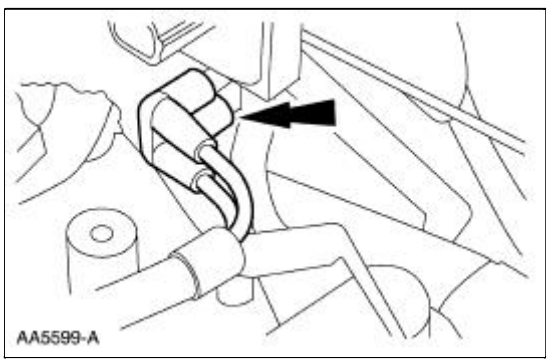
11. Disconnect the hoses from the differential pressure feedback EGR transducer.



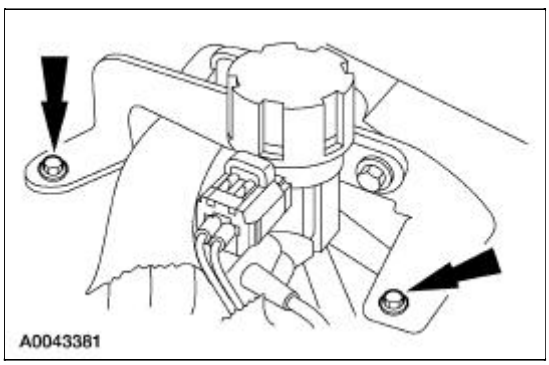
12. Disconnect the EGR vacuum regulator solenoid electrical connector.



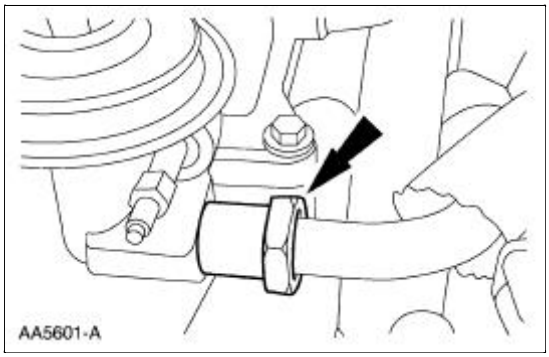
13. Disconnect the EGR vacuum regulator solenoid vacuum supply.



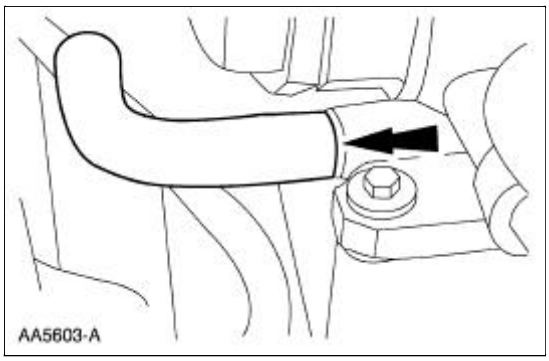
14. Remove the bolts retaining the EGR vacuum regulator solenoid bracket to the intake manifold.



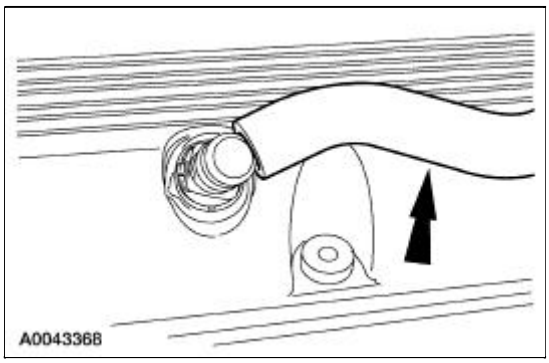
15. Disconnect the exhaust gas recirculation (EGR) tube from the EGR valve.



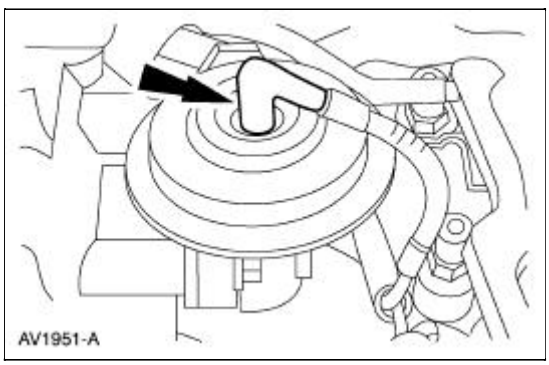
16. Disconnect the positive crankcase ventilation (PCV) hose from the base of the throttle body and spacer assembly.



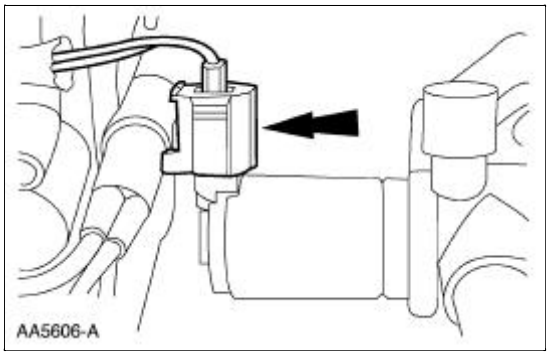
17. Disconnect the hose from the PCV valve.



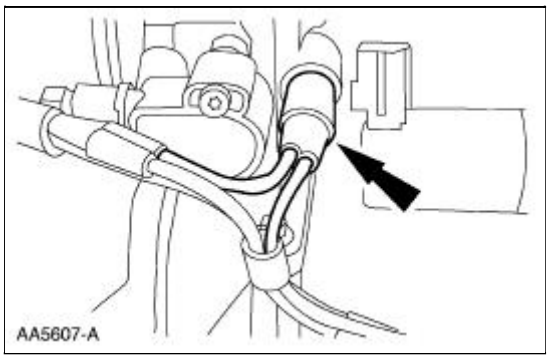
18. Disconnect the vacuum hose from the EGR valve.



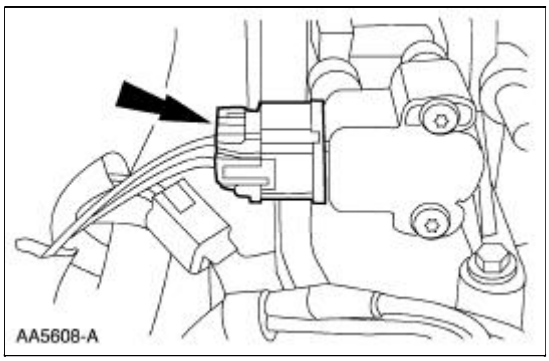
19. Disconnect the idle air control (IAC) valve electrical connector.



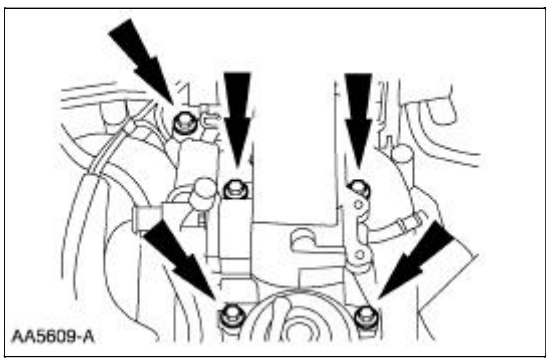
20. Disconnect the main vacuum supply from the base of the throttle body adapter.



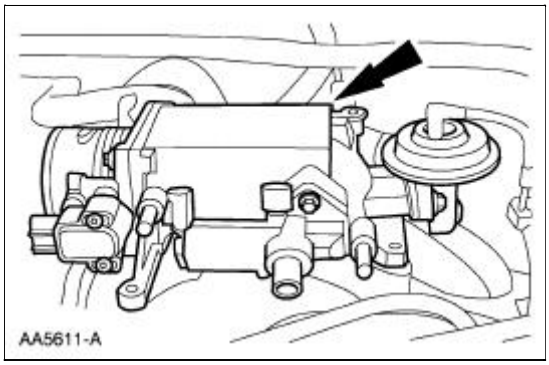
21. Disconnect the throttle position sensor (TPS) electrical connector.



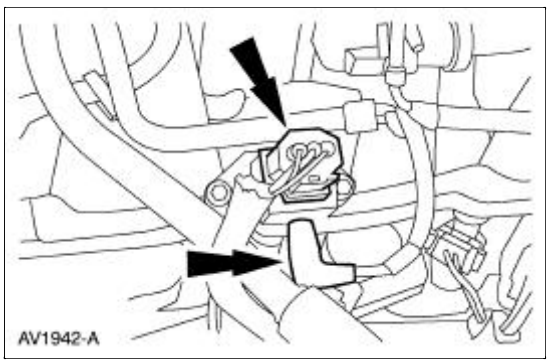
22. Remove the bolts.



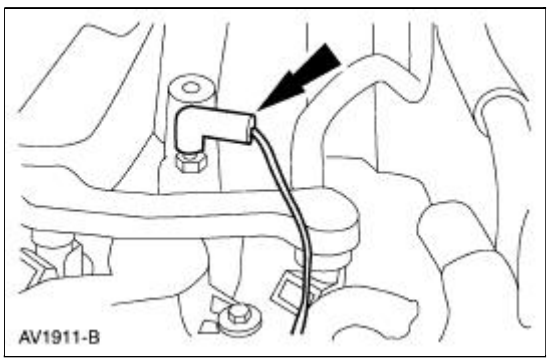
23. Remove the throttle body and adapter as an assembly.
    - Inspect and clean the sealing surfaces.
        - The gasket is reusable if not damaged.



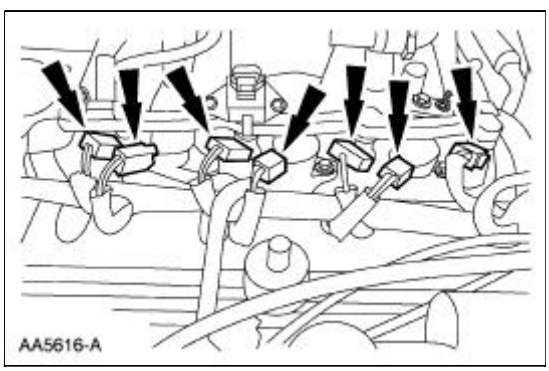
24. Disconnect the fuel pressure sensor electrical connector and the vacuum hose.



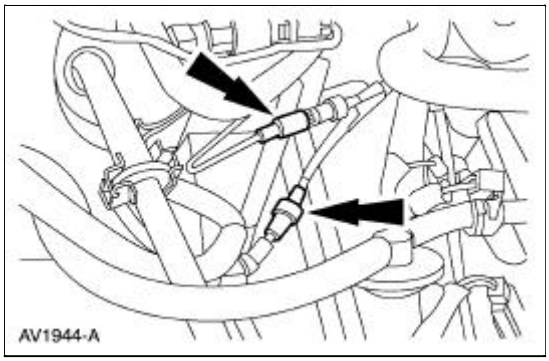
25. Disconnect the fuel charging ground wire.



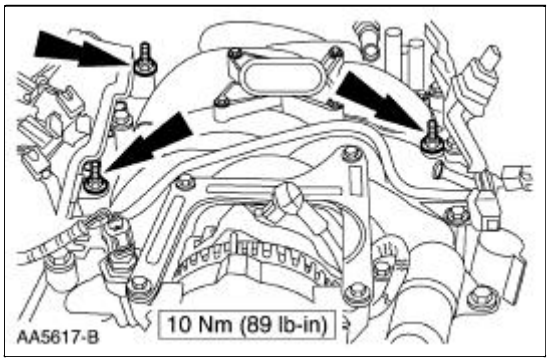
26. Disconnect the ignition coils and the fuel injectors.



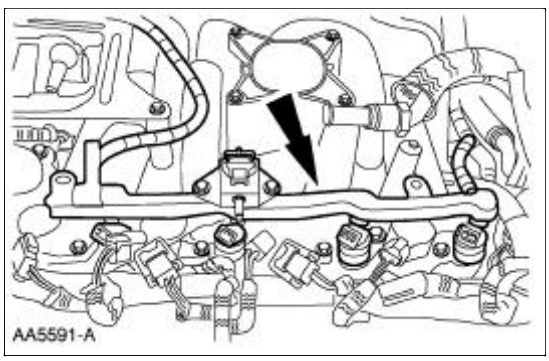
27. Disconnect the climate control vacuum supply hoses and remove the vacuum harness.



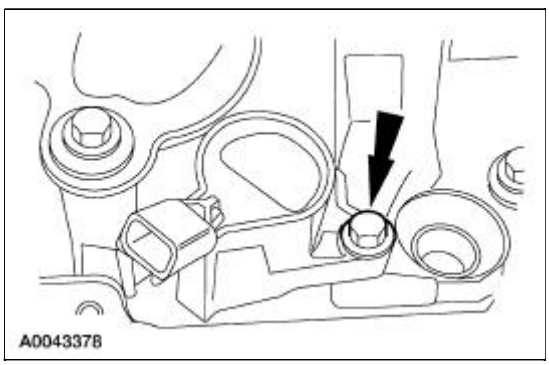
28. Remove the four studs.



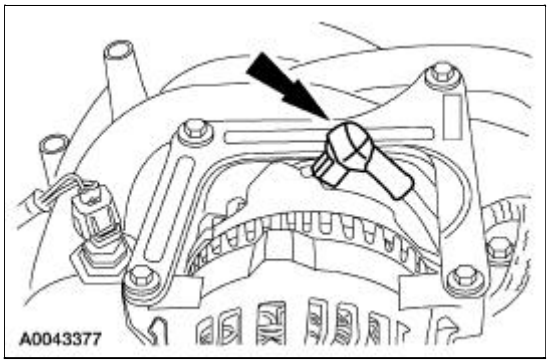
29. Remove the injectors and fuel injection supply manifold as an assembly.



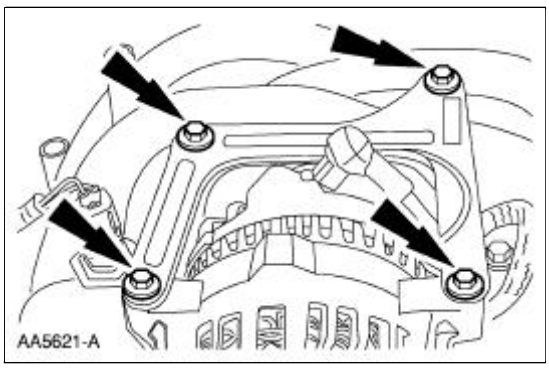
30. Remove the ignition coils.



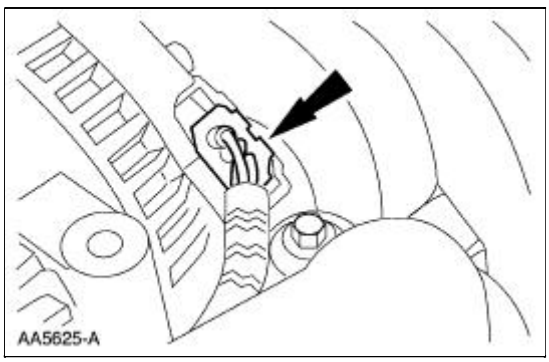
31. Disconnect the battery terminal.



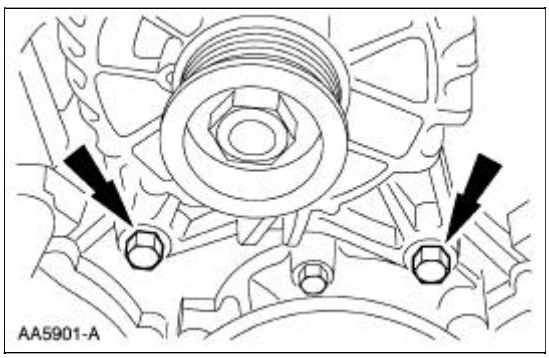
32. Remove the generator support brace.



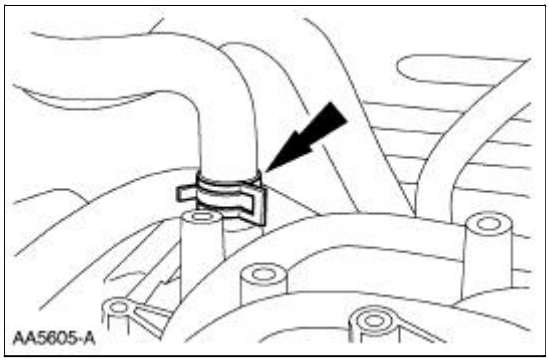
33. Disconnect the electrical connector.



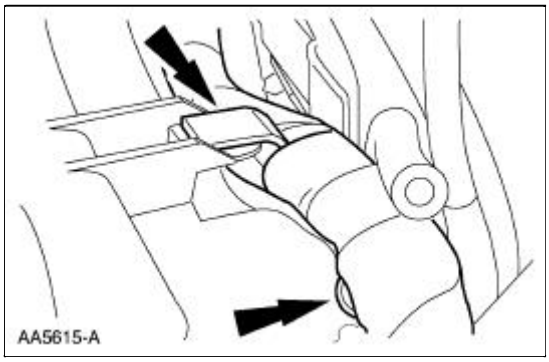
34. Remove the generator.



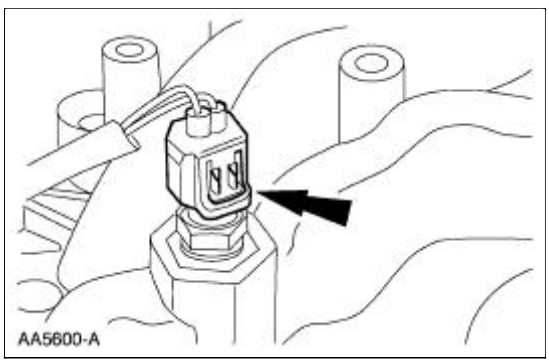
35. Disconnect the heater hose.



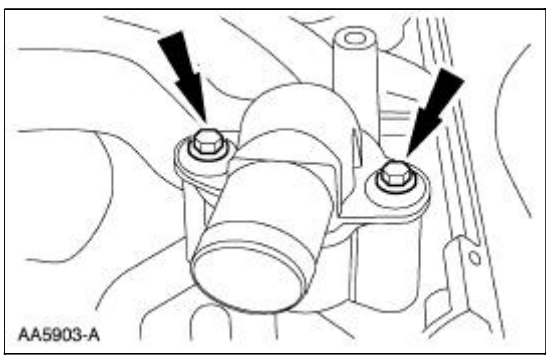
36. Separate the engine harness and position it out of the way.



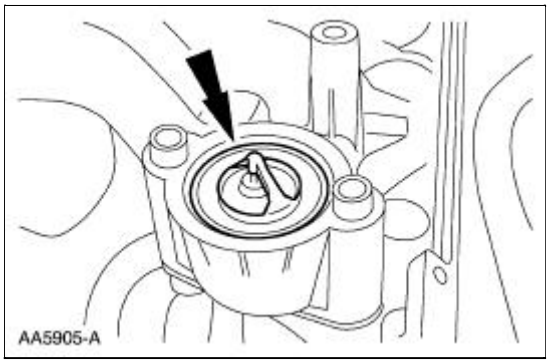
37. Disconnect the water temperature indicator sender.



38. Remove the water outlet connector.

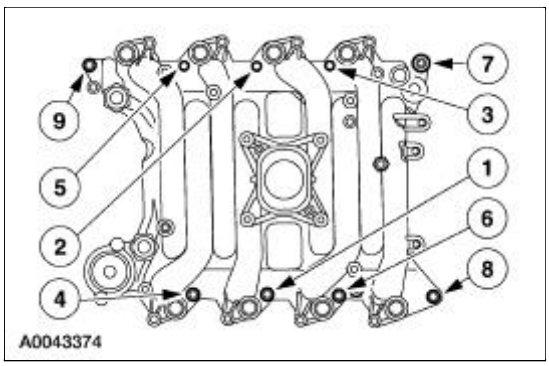


39. Remove the water thermostat and the O-ring.
    - Inspect the O-ring and discard if necessary.



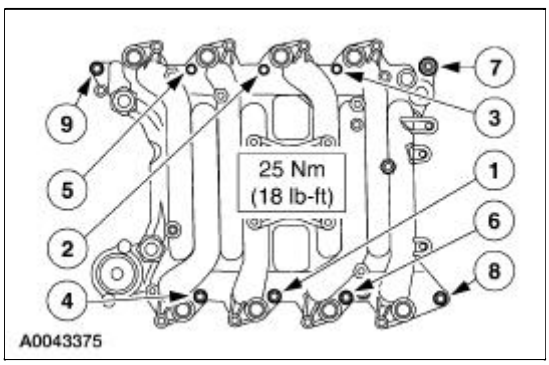
40. **NOTE:** The gaskets are reusable if not damaged.

    Remove the bolts in the sequence shown, remove the intake manifold and gaskets.



Installation

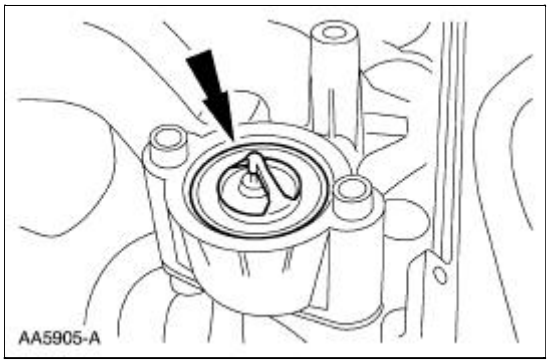
1. Install the intake manifold and gaskets, tighten the bolts in the sequence shown.



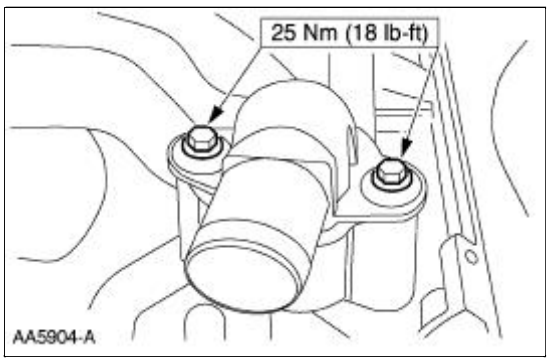
2. **NOTE:** The O-ring is to be installed on the top of the thermostat.

   Install the water thermostat and the O-ring.

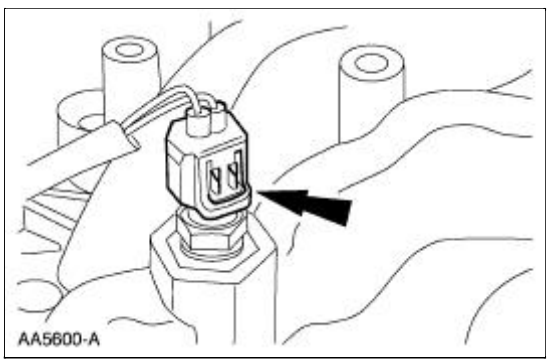
   - Install a new O-ring as necessary.



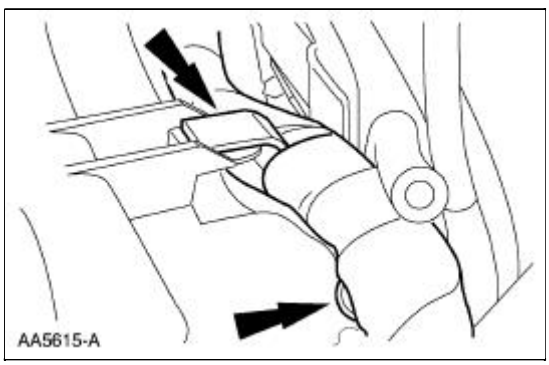
3. Install the water outlet adapter.



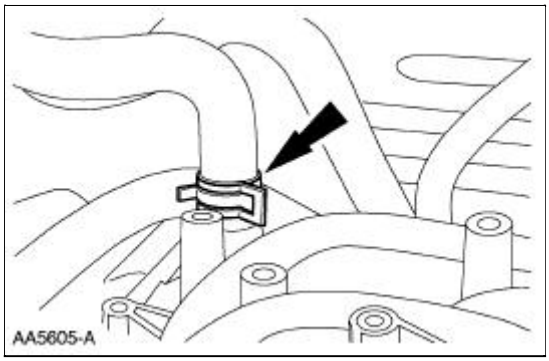
4. Connect the water temperature indicator sender.



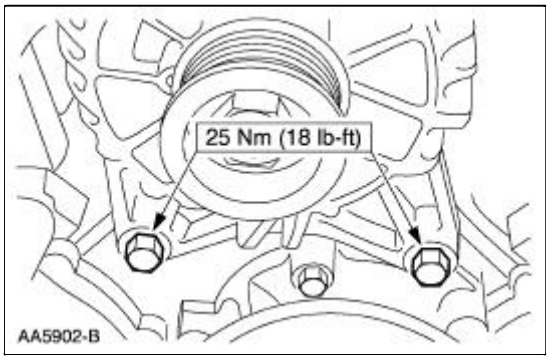
5. Position the engine harness and attach to the intake manifold in two locations.



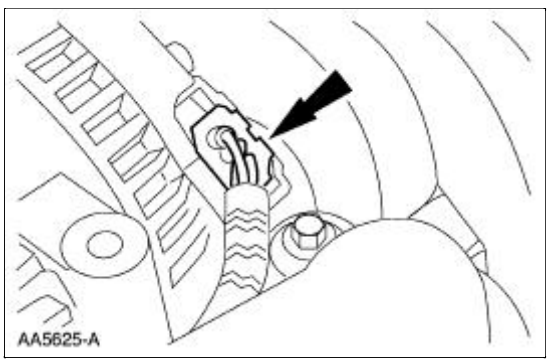
6. Connect the heater hose.



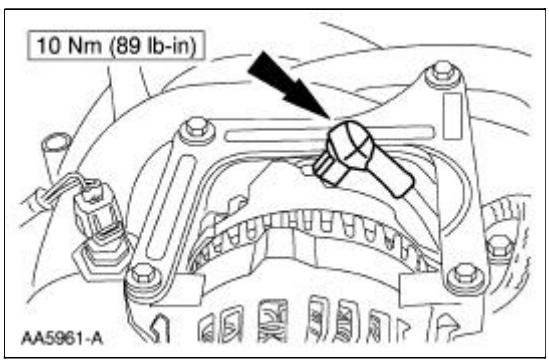
7. Install the generator.



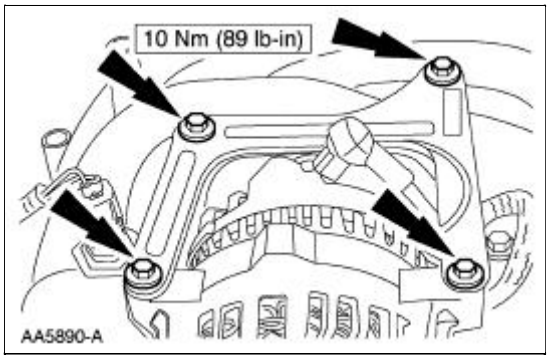
8. Connect the electrical connector.



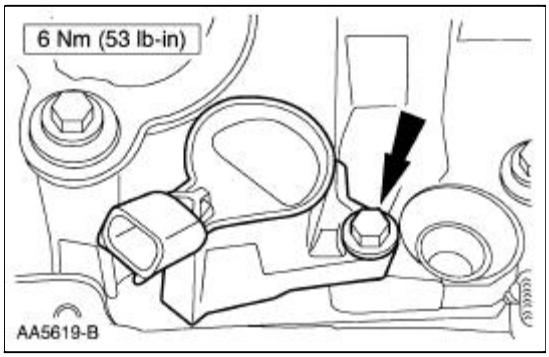
9. Connect the battery lead.



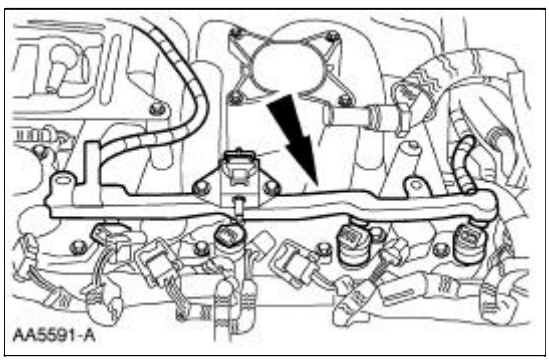
10. Install the generator support brace.



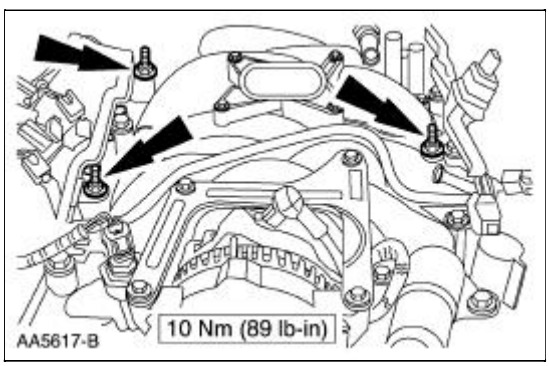
11. Install the ignition coils.



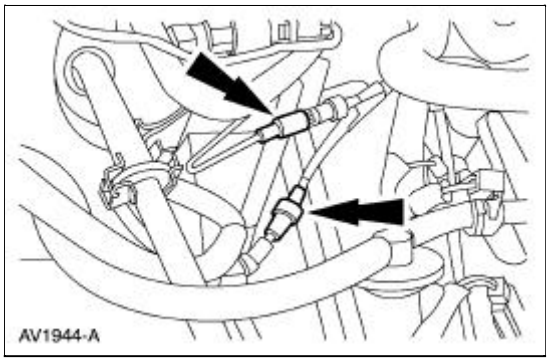
12. Install the fuel injection supply manifold and fuel injectors as an assembly.



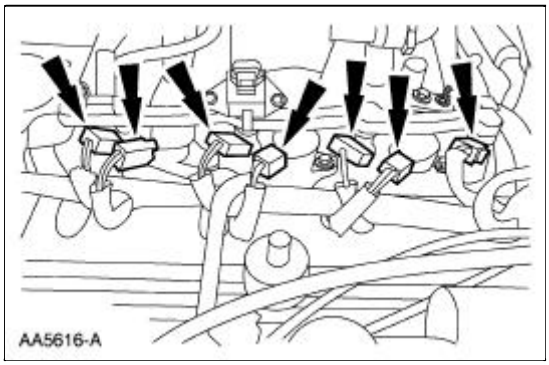
13. Install four studs.



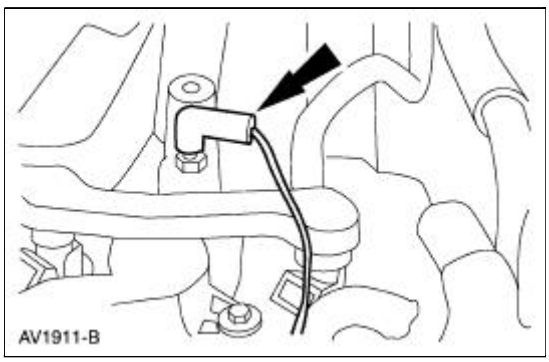
14. Position the vacuum harness and connect to the climate control vacuum supply hoses.



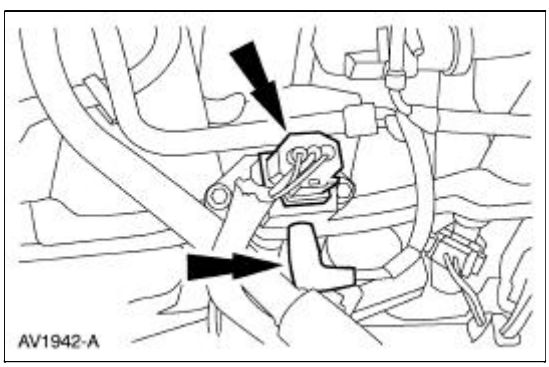
15. Connect the ignition coils and the fuel injectors.



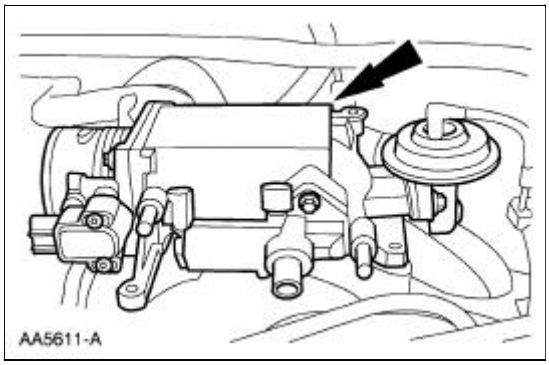
16. Connect the fuel charging ground wire.



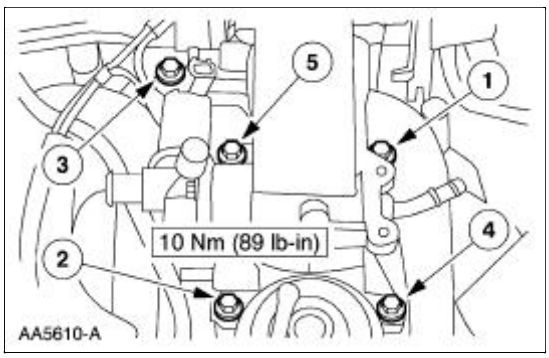
17. Connect the fuel pressure sensor electrical connector and the vacuum hose.



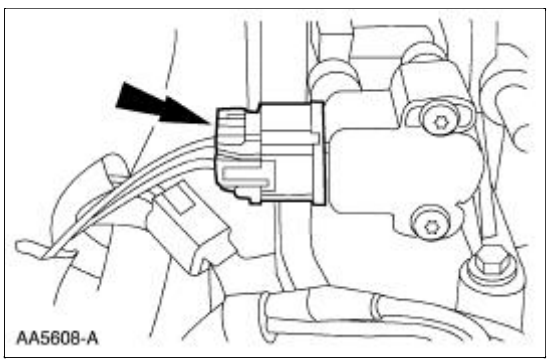
18. Install the throttle body and adapter as an assembly.



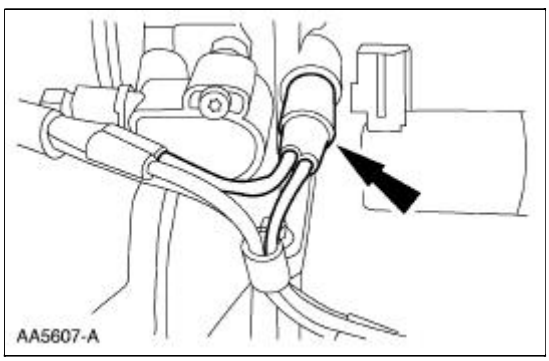
19. Tighten the bolts in the sequence shown.



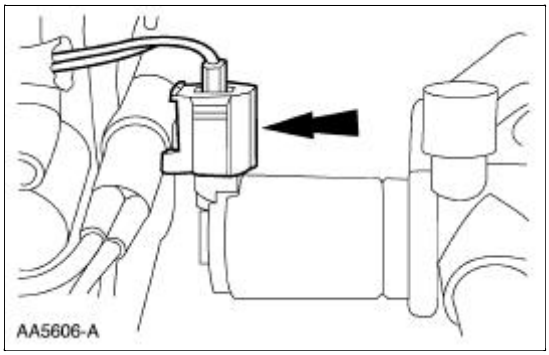
20. Connect the throttle position sensor (TPS) electrical connector.



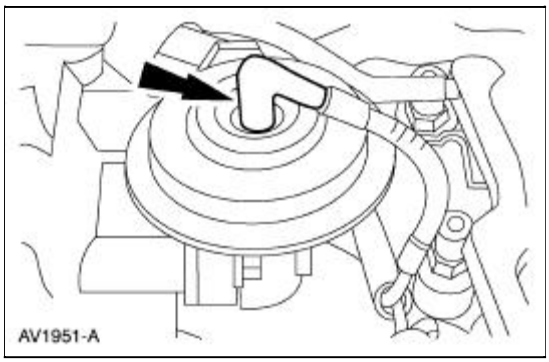
21. Connect the main vacuum supply to the base of the throttle body adapter.



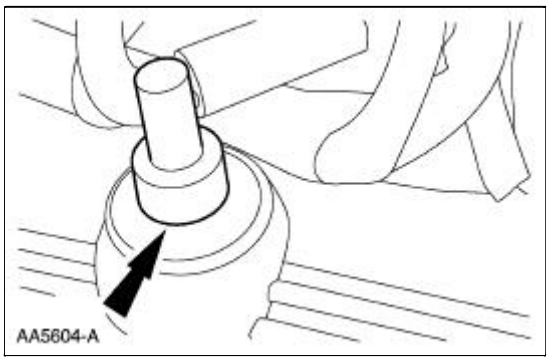
22. Connect the idle air control (IAC) valve electrical connector.



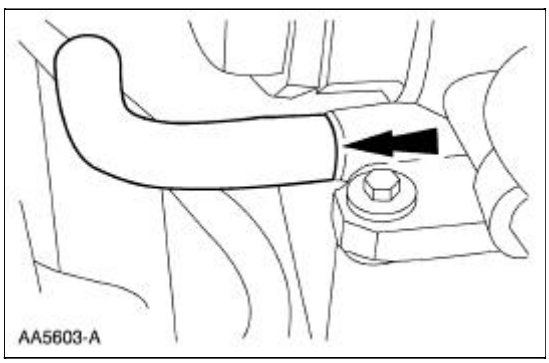
23. Connect the vacuum hose to the EGR valve.



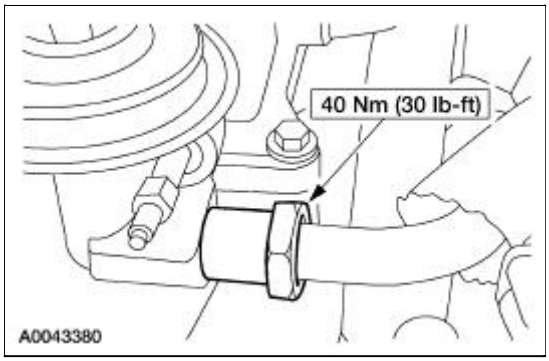
24. Connect the hose to the PCV valve.



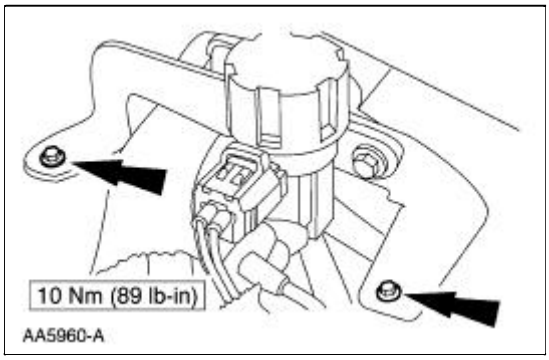
25. Connect the PCV hose to the base of the throttle body assembly.



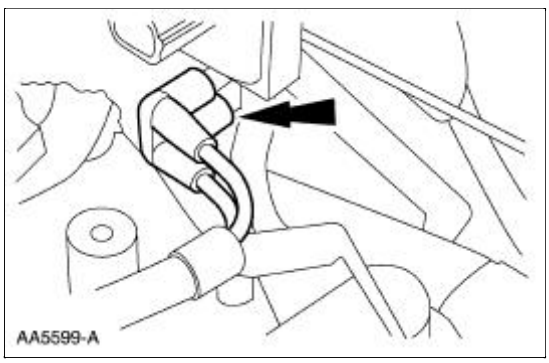
26. Connect the EGR tube to the EGR valve.



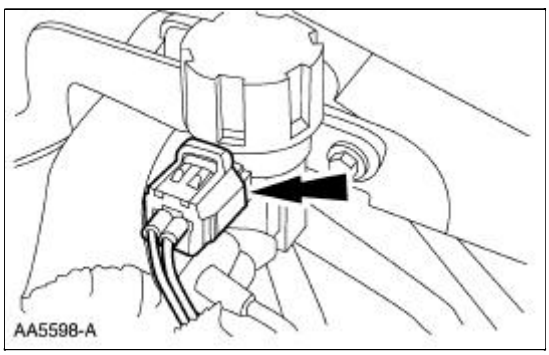
27. Install the EGR vacuum regulator solenoid bracket.



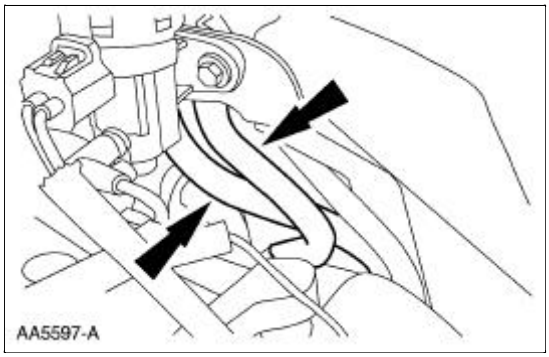
28. Connect the EGR vacuum regulator solenoid vacuum supply.



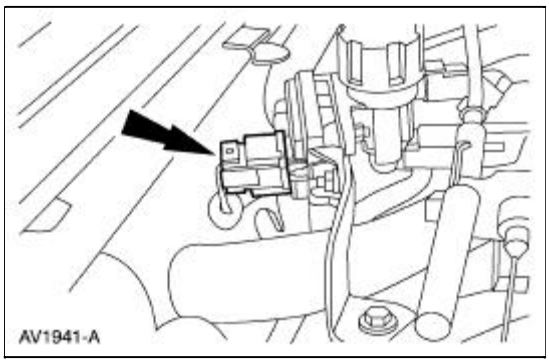
29. Connect the EGR vacuum regulator solenoid electrical connector.



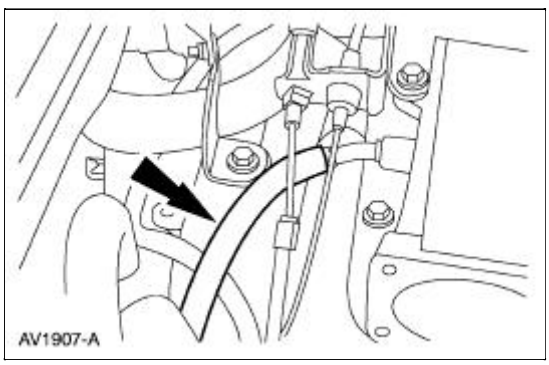
30. Connect the hoses to the differential pressure feedback EGR transducer.



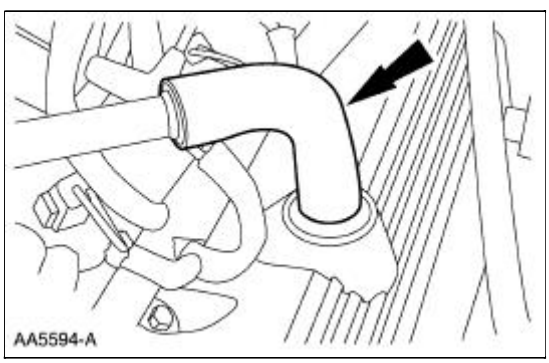
31. Connect the differential pressure feedback EGR electrical connector.



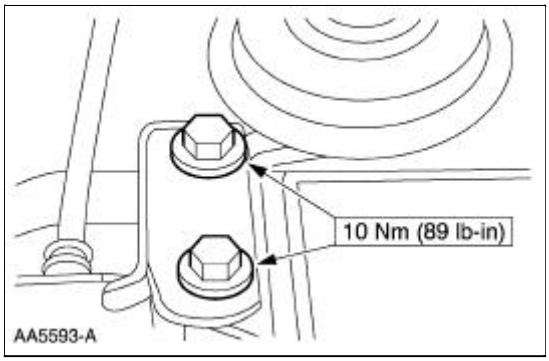
32. Connect the evaporative emissions return line.



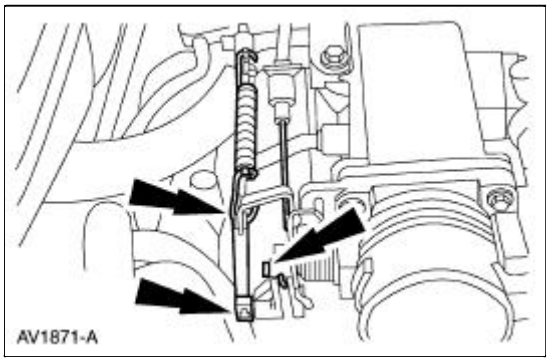
33. Install the breather tube.



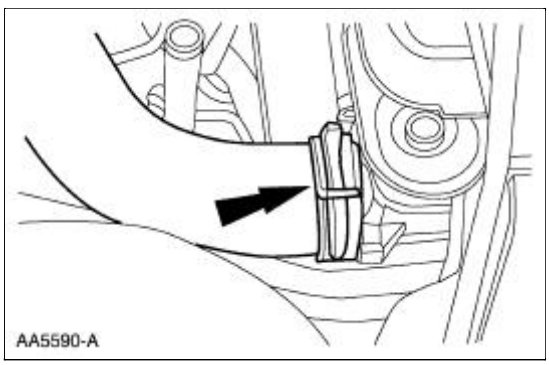
34. Position the cables and install the bracket.



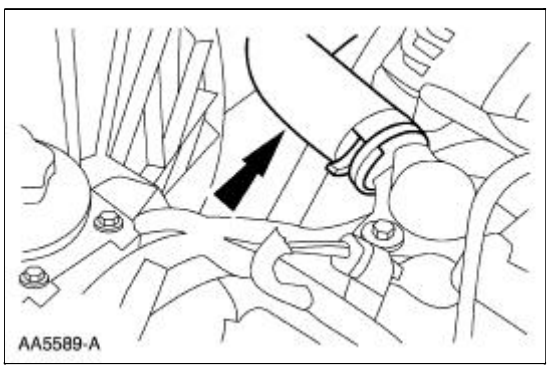
35. Connect the accelerator cable, speed control actuator cable and the return spring.



36. Connect the upper radiator hose.



37. Connect the upper radiator hose to the water outlet adapter.



38. Connect the fuel line. For additional information, refer to Section 310-00 .

39. Install the air cleaner outlet tube. For additional information, refer to Section 303-12 .

40. Refill the engine cooling system. For additional information, refer to Section 303-03A or Section 303-03B .

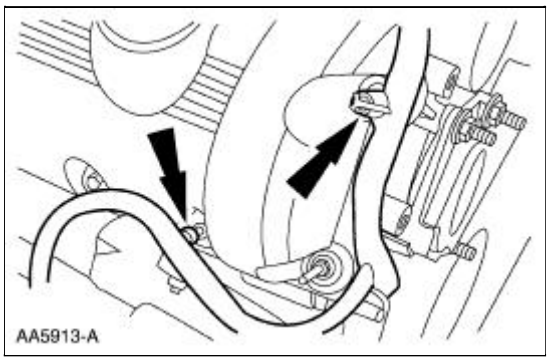
Valve Cover RH

Material

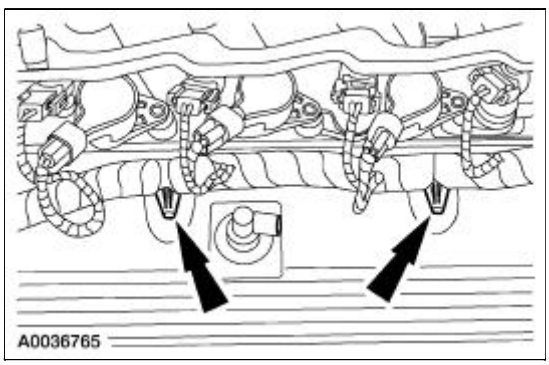
Item	Specification
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4

Removal and Installation

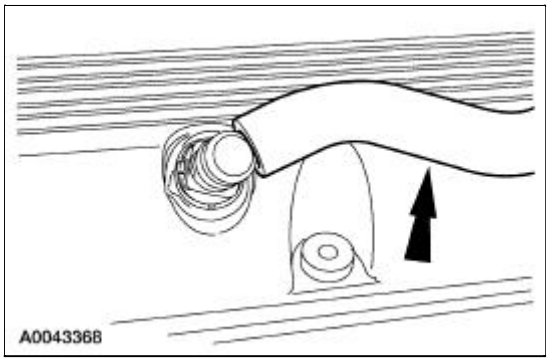
1. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .
2. Disconnect the fuel line. For additional information, refer to Section 310-00 .
3. Separate the engine wiring harness from the valve cover studs.



4. Separate the engine wiring harness from the valve cover studs.

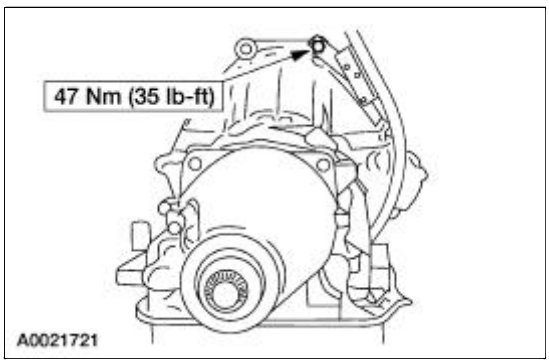


5. Remove the positive crankcase ventilation (PCV) hose from the valve cover and position aside.

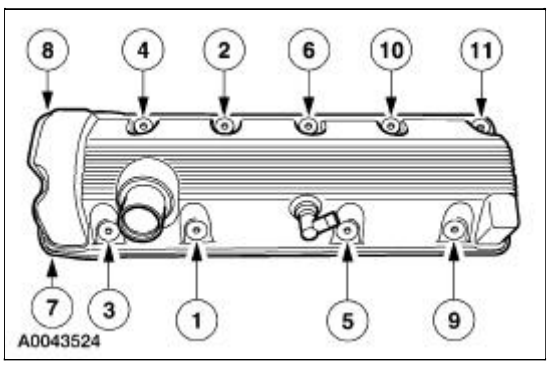


6. Raise and support the vehicle. For additional information, refer to Section 100-02 .

7. Remove the bolt and position the transmission filler tube aside.

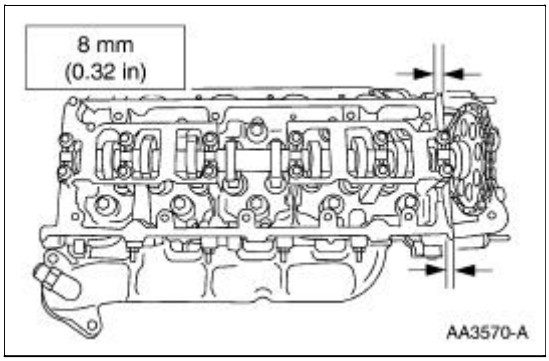


8. Remove the bolts, studs and the valve cover in the sequence shown.
    - Clean and inspect the sealing surfaces.



9. **NOTE:** Apply an eight millimeter bead of silicone gasket and sealant at the intersection of the engine front cover and the cylinder head.

    To install, reverse the removal procedure.


8 mm
(0.32 in)
AA3570-A

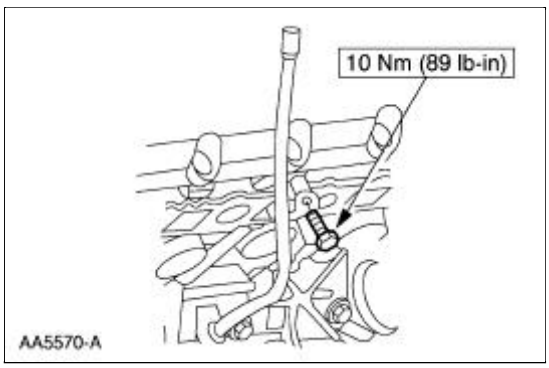
Valve Cover LH

Material

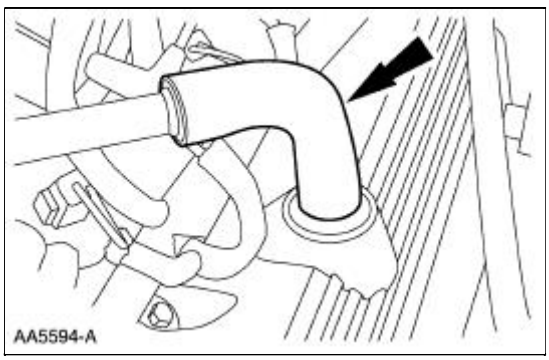
Item	Specification
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4

Removal and Installation

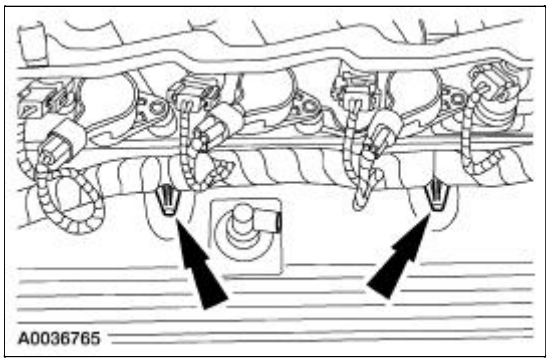
1. Position the oil level tube (6754) out of the way.



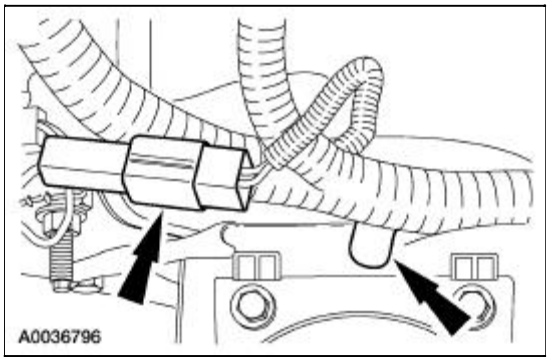
2. Disconnect the breather tube.



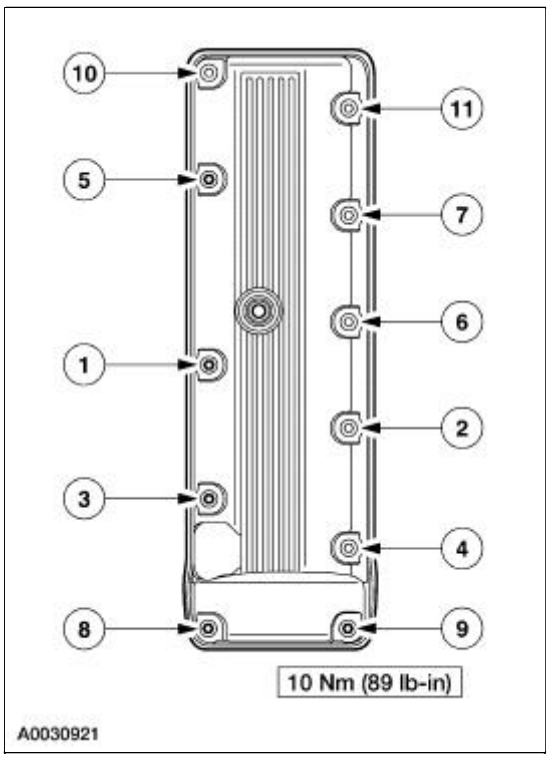
3. Separate the engine wiring harness in the locations shown.



4. Disconnect the engine wiring harness retainer and position it aside.

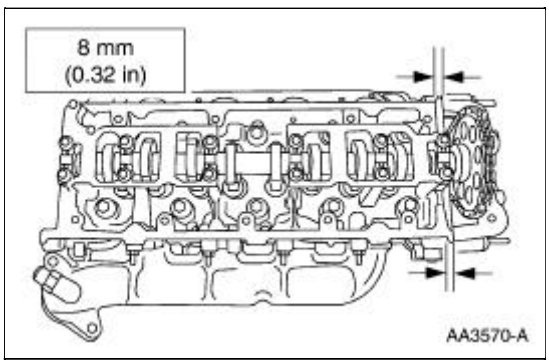


5. Remove the bolts, studs and the valve cover in the sequence shown.
    - Inspect and clean the sealing surfaces.



6. **NOTE:** Apply an eight millimeter bead of silicone gasket and sealant at the intersection of the engine front cover and the cylinder head.

    To install, reverse the removal procedure.



Crankshaft Pulley

Special Tool(s)

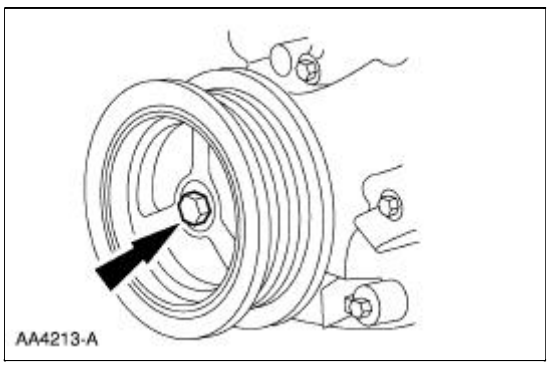
ST1286-A	Remover, Crankshaft Vibration Damper 303-009 (T58P-6316-D)
ST1287-A	Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)

Material

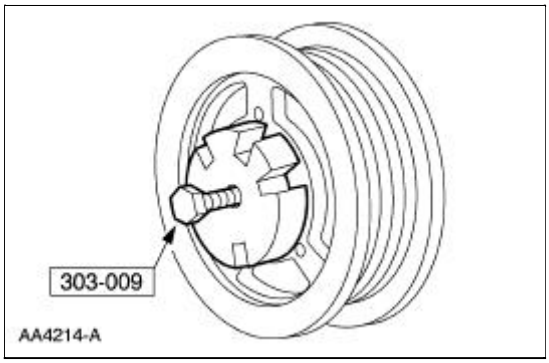
Item	Specification
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4

Removal

1. Remove the drive belt. For additional information, refer to Section 303-05 .
2. Raise and support the vehicle. For additional information, refer to Section 100-02 .
3. Remove the bolt.



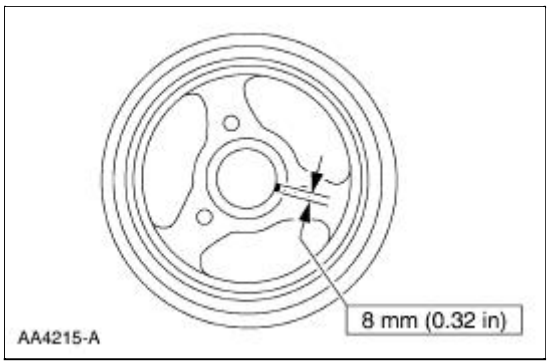
4. Using the special tool, remove the crankshaft pulley (6312).



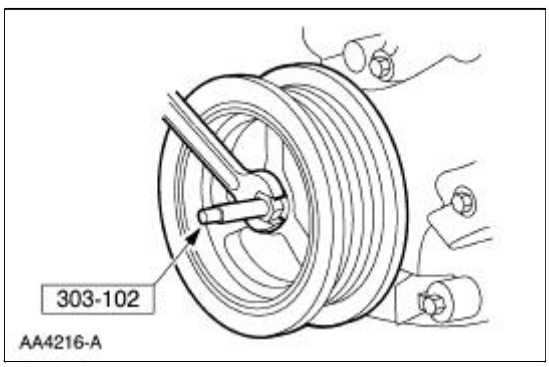
Installation

1. **NOTE:** The crankshaft pulley must be installed within four minutes of applying the sealant.

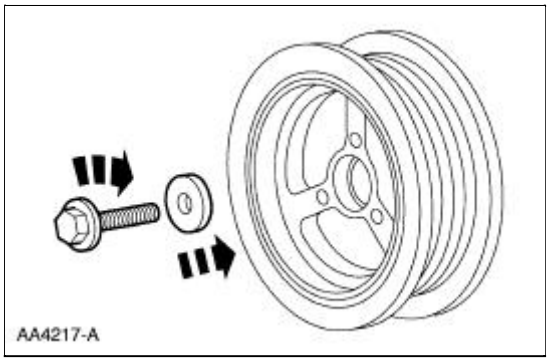
   Apply sealant to the woodruff key slot on the crankshaft pulley.



2. Using the special tool, install the crankshaft pulley.



3. Install the washer and the bolt. Tighten the bolt in four stages.
   - Stage 1: Tighten the bolt to 90 Nm (66 lb-ft).
   - Stage 2: Loosen the bolt one full turn.
   - Stage 3: Tighten the bolt to 50 Nm (37 lb-ft).
   - Stage 4: Tighten the bolt an additional 90 degrees.



4. Lower the vehicle.
5. Install the drive belt. For additional information, refer to Section 303-05 .

Crankshaft Front Oil Seal

Special Tool(s)

ST1328-A	Crankshaft Seal Installer/Aligner 303-335 (T88T-6701-A)
ST1288-A	Front Cover Seal Remover 303-107 (T74P-6700-A)
ST2197-A	Crankshaft Seal Installer 303-635
ST1287-A	Crankshaft Damper Replacer 303-102 (T74P-6316-B)

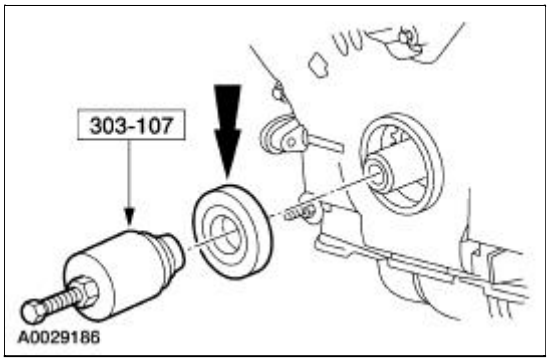
Material

Item	Specification
Super Premium SAE 5W-20 Engine Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

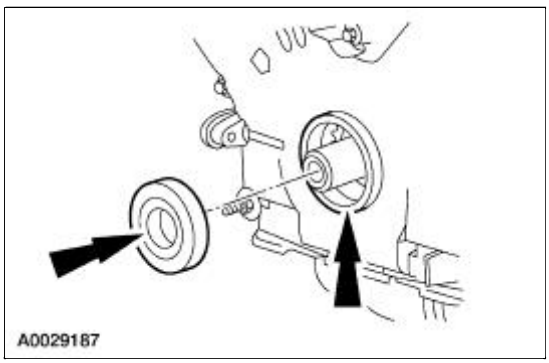
1. Remove the crankshaft pulley. For additional information, refer to Crankshaft Pulley in this section.

2. Using the special tool, remove the crankshaft front oil seal.

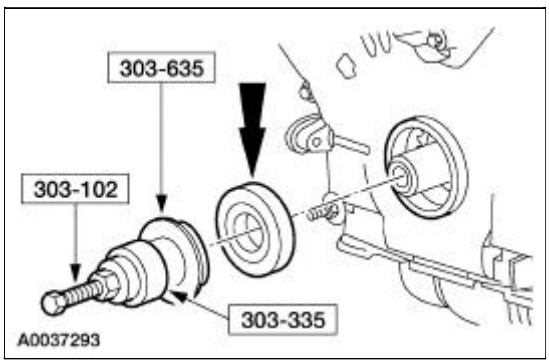


Installation

1. Lubricate the engine front cover and the crankshaft front oil seal inner lip with clean engine oil.



2. Using the special tools, install the crankshaft front oil seal into the engine front cover.



3. Install the crankshaft pulley. For additional information, refer to Crankshaft Pulley .

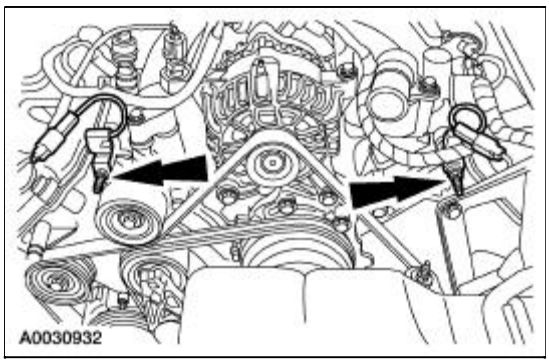
Engine Front Cover

Material

Item	Specification
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4
Super Premium SAE 5W-20 Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

1. Remove the nuts and position the radio ignition interference capacitors aside.

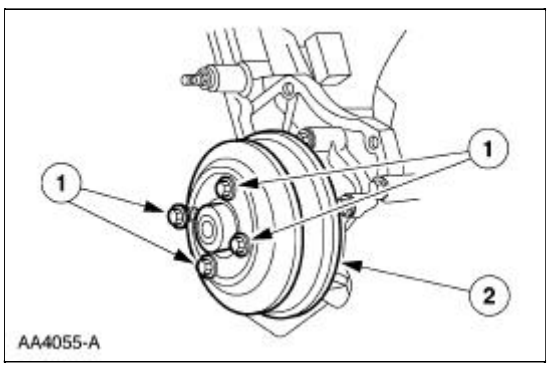


2. Remove the valve covers. For additional information, refer to Valve Cover RH and Valve Cover LH in this section.

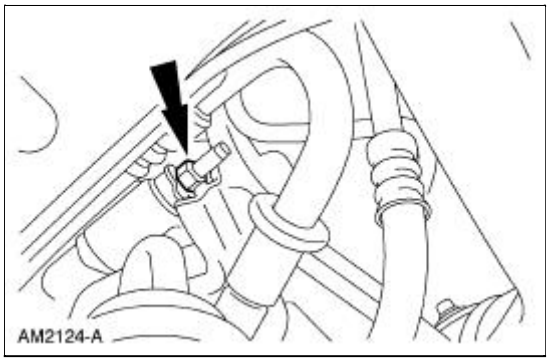
3. Remove the cooling fan. For additional information, refer to Section 303-03A or Section 303-03B .

4. Remove the accessory drive belt. For additional information, refer to Section 303-05 .

5. Remove bolts (1) and the water pump pulley (2).

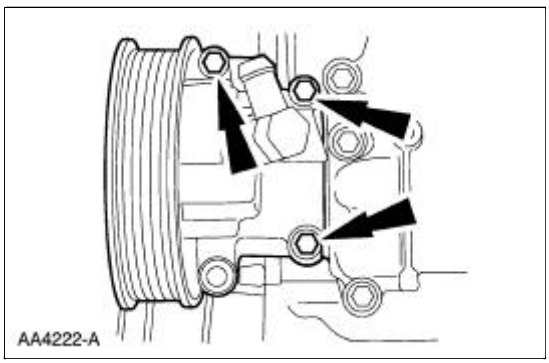


6. Remove the nut and position the A/C muffler aside.

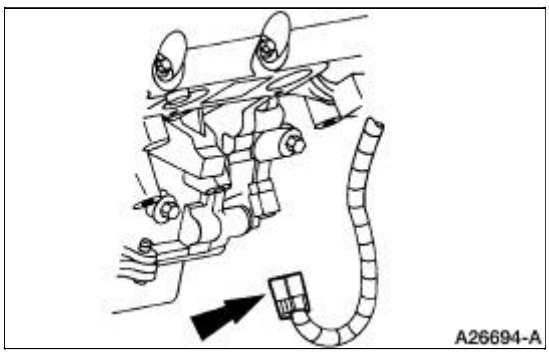


7. Raise and support the vehicle. For additional information, refer to Section 100-02 .

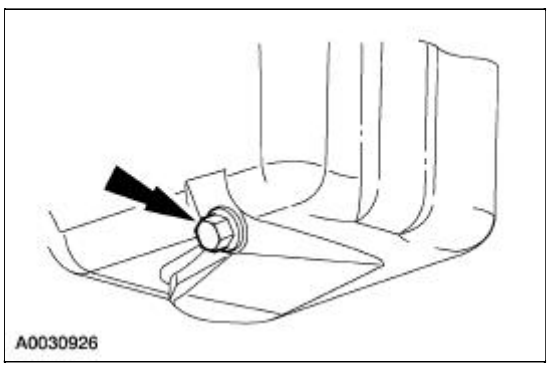
8. Remove the bolts and position the power steering pump aside.



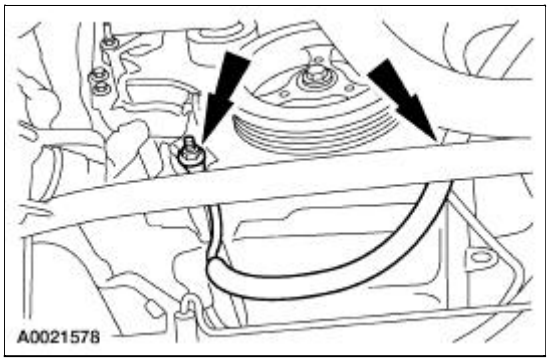
9. Disconnect the crankshaft position (CKP) sensor electrical connector.



10. Drain the engine oil.

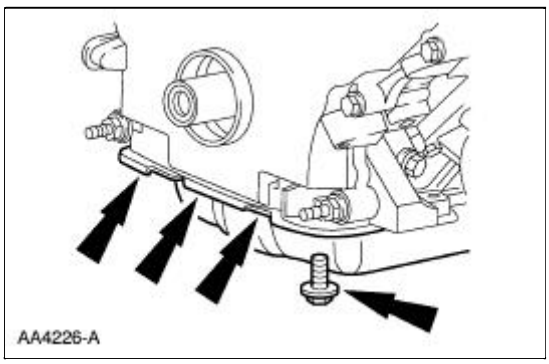


11. Remove the two support nuts and position the battery cable aside.



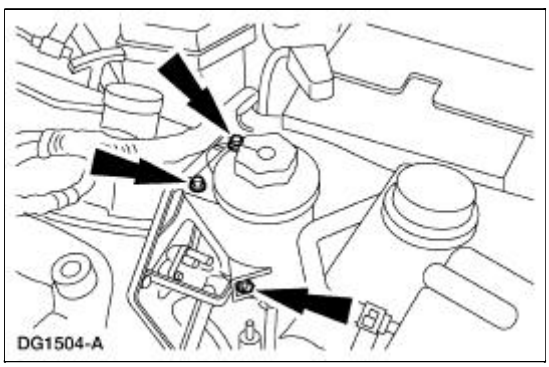
12. Remove the crankshaft front oil seal. For additional information, refer to Crankshaft Front Oil Seal in this section.

13. Remove the front oil pan bolts.

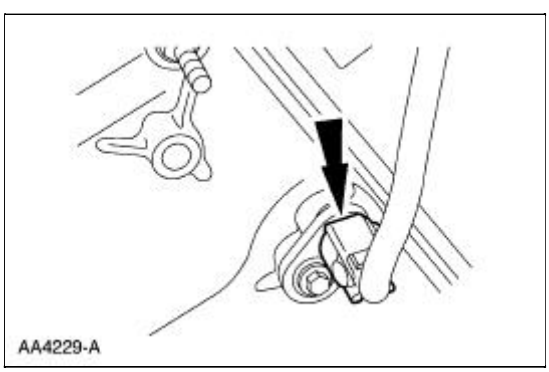


14. Lower the vehicle.

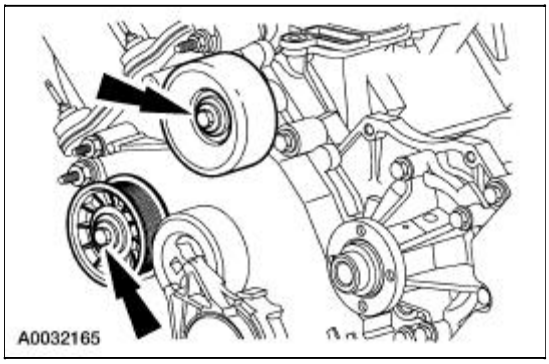
15. Remove the bolts and position the power steering reservoir aside.



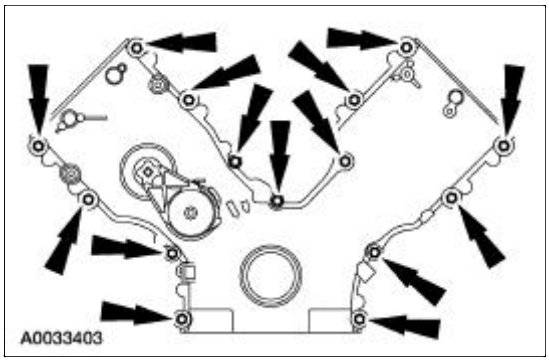
16. Disconnect the camshaft position (CMP) sensor electrical connector.



17. Remove the bolts and the belt idler pulleys.

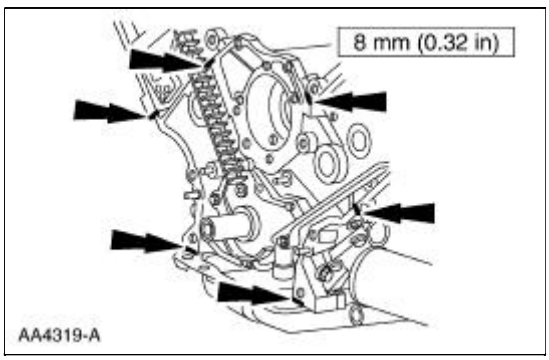


18. Remove the engine front cover bolts and the studs.
    - Discard the gaskets. Clean and inspect the sealing surfaces.

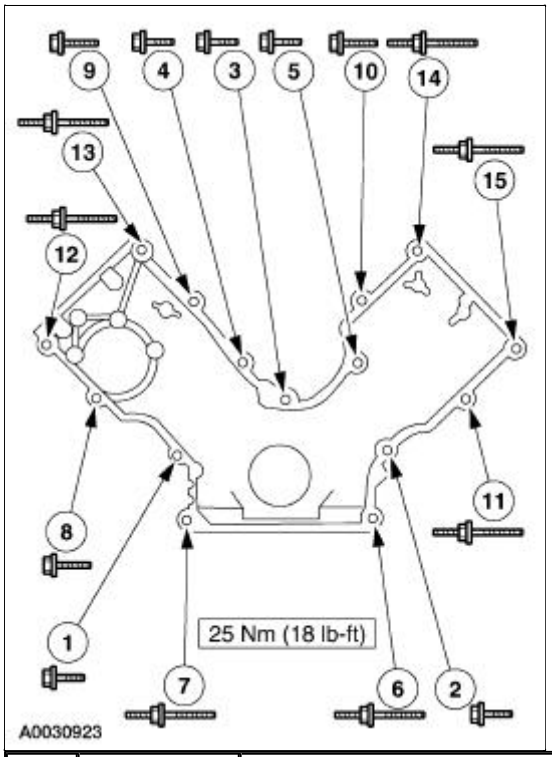


Installation

1. Apply silicone gasket and sealant in the locations shown.

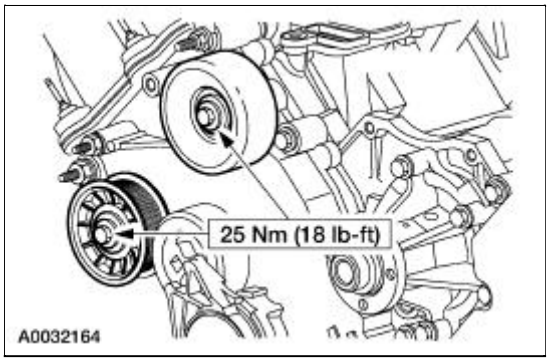


2. Install the engine front cover.

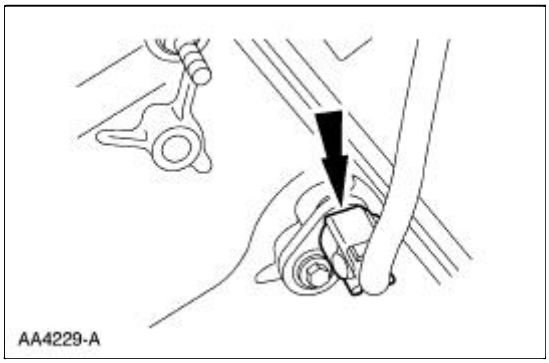


Item	Part Number	Description
1	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
2	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
3	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
4	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
5	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
6	W706508	Stud, Hex Shldr Pilot, M8 x 1.25 x 50 — M6 x 1 x 10
7	N808586	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 60 — M6 x 1 x 26
8	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
9	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
10	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
11	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26
12	W706560	Stud, Hex Head Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 16
13	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26
14	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26
15	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26

3. Install the belt idler pulleys and the bolts.



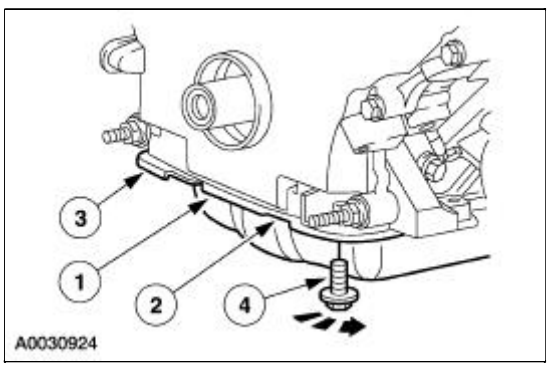
4. Connect the CMP sensor electrical connector.



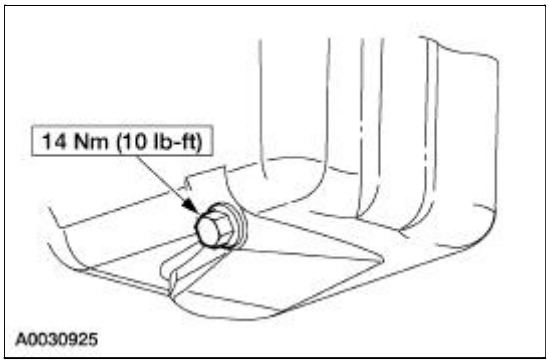
5. Raise the vehicle.

6. Install the crankshaft front oil seal. For additional information, refer to Crankshaft Front Oil Seal in this section.

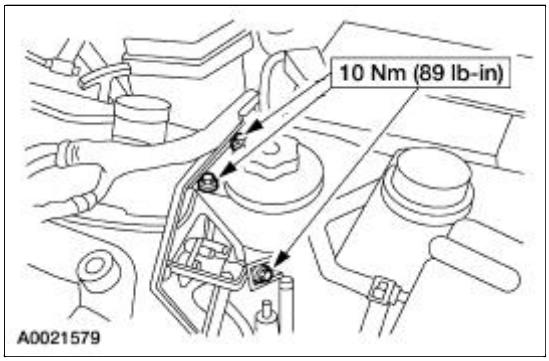
7. Tighten the four oil pan bolts in the sequence shown.
   - Stage 1: Tighten to 2 Nm (18 lb-in).
   - Stage 2: Tighten to 20 Nm (15 lb-ft).
   - Stage 3: Tighten an additional 60 degrees.



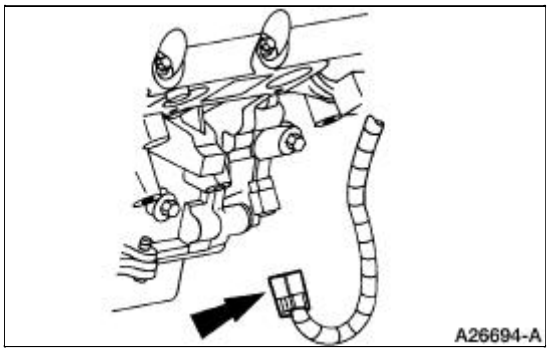
8. Install the drain plug.



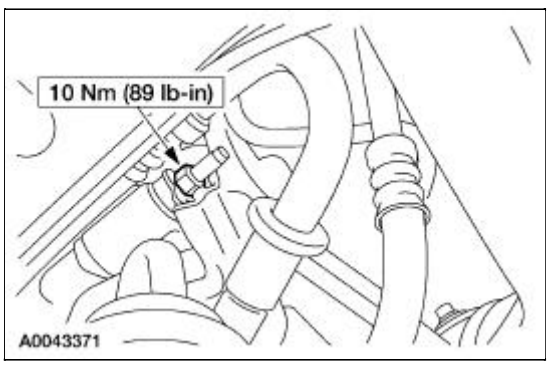
9. Position the power steering reservoir and install the bolts.



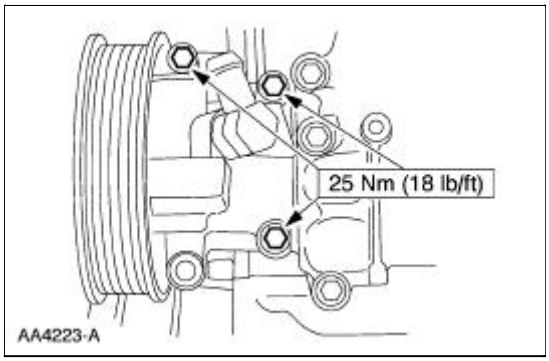
10. Connect the CKP sensor electrical connector.



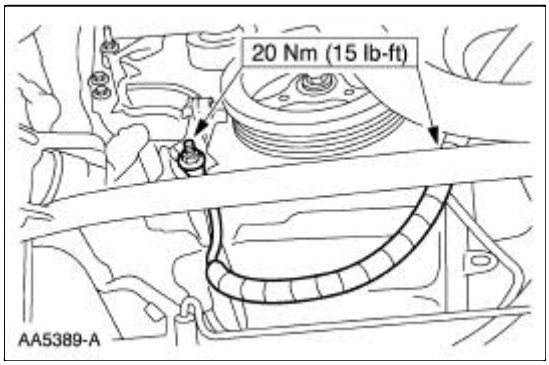
11. Position the A/C muffler and tighten the nut.



12. Install the power steering pump and the bolts.

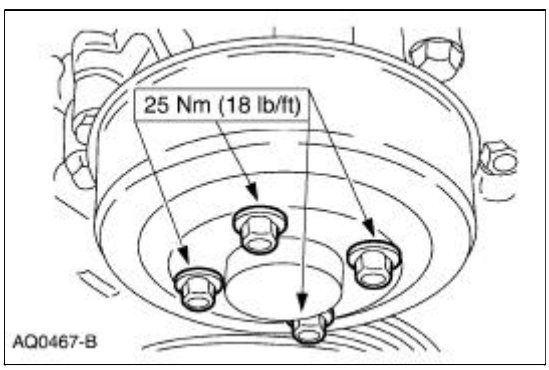


13. Position the battery cable and install the two nuts.



14. Install the crankshaft pulley. For additional information, refer to Crankshaft Pulley in this section.

15. Install the water pump pulley and the bolts.

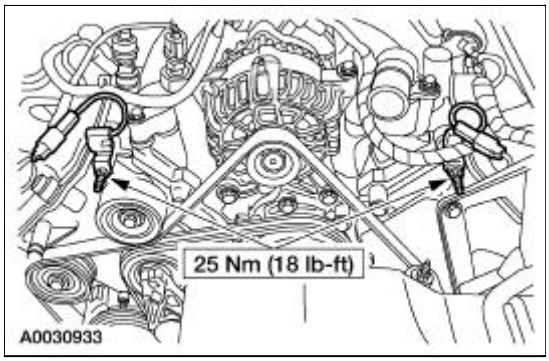


16. Install the cooling fan. For additional information, refer to Section 303-03A or Section 303-03B .

17. Install the accessory drive belt. For additional information, refer to Section 303-05 .

18. Install the valve covers. For additional information, refer to Valve Cover RH and Valve Cover LH in this section.

19. Position the radio ignition interference capacitors and install the nuts.



20. Fill the crankcase with clean engine oil.

Timing Drive Components

Special Tool(s)

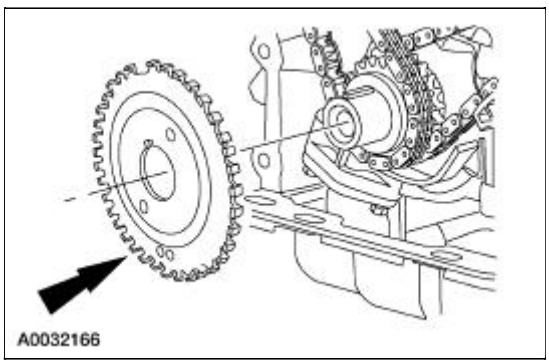
ST1693-A	Compressor, Valve Spring 303-567 (T97P-6565-AH)
ST1335-A	Holding Tool, Crankshaft 303-448 (T93P-6303-A)
	Aligner, Camshaft Position 303-557 (T96T-6256-B)

Removal

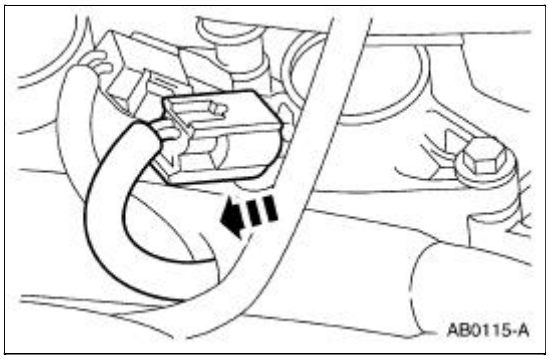
CAUTION: Since the engine is not free-wheeling, timing procedures must be followed exactly or piston and valve damage can occur.

1. Remove the engine front cover. For additional information, refer to Engine Front Cover in this section.

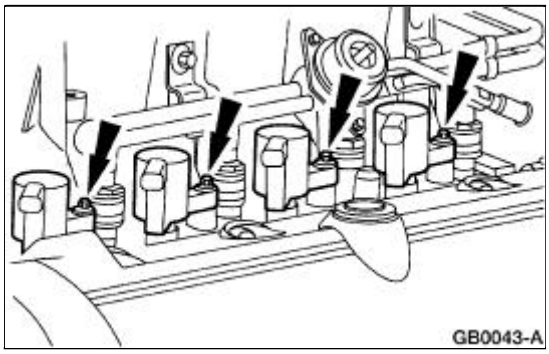
2. Remove the crankshaft sensor ring from the crankshaft.


A0032166

3. Disconnect the eight ignition coil electrical connectors.

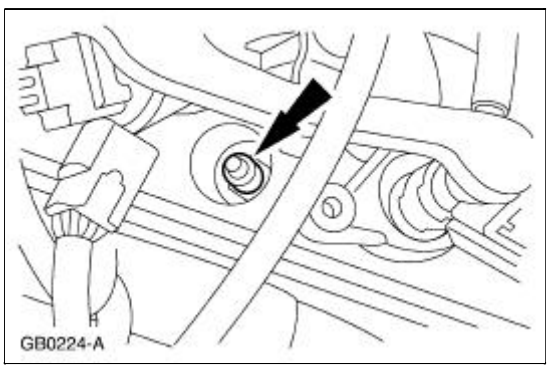


4. Remove the bolts and the eight ignition coils.



5. **NOTE:** Use compressed air to remove any foreign material from the spark plug wells before removing the spark plugs.

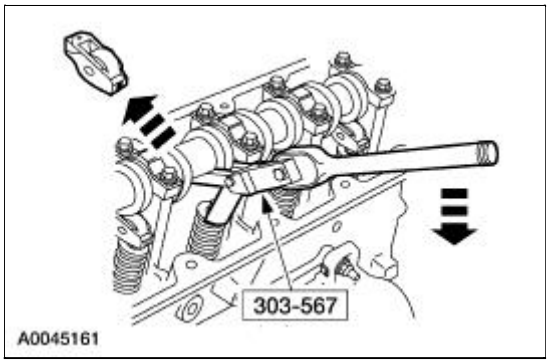
   Remove the spark plugs.



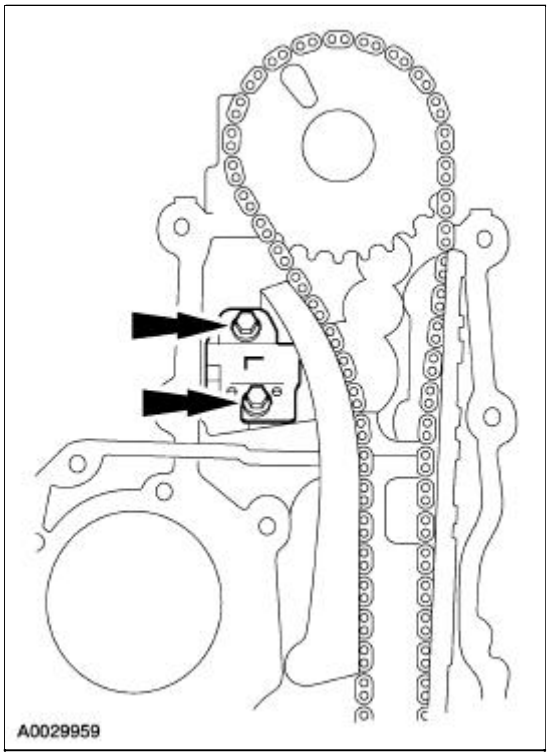
6. **NOTE:** Rotate the camshaft to the base circle of the camshaft lobe before removing the followers. Keep the roller followers in order when removing.

   Using the special tool, remove the 16 roller followers.

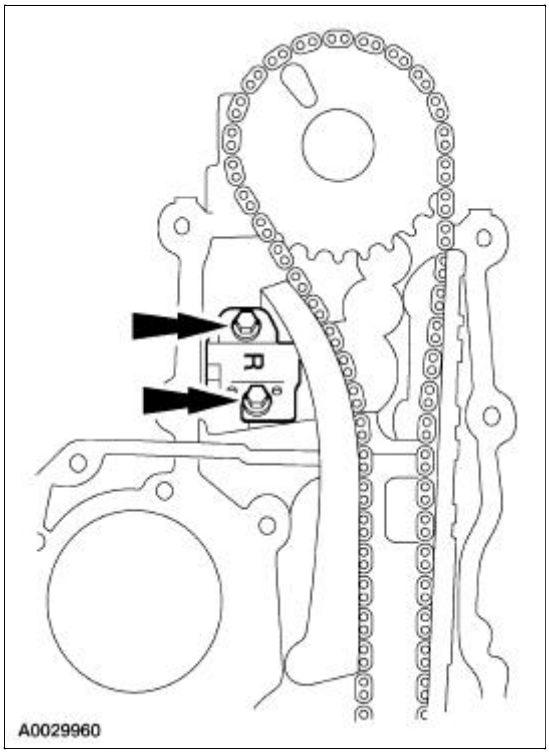
   - Rotate the crankshaft and camshaft as necessary.



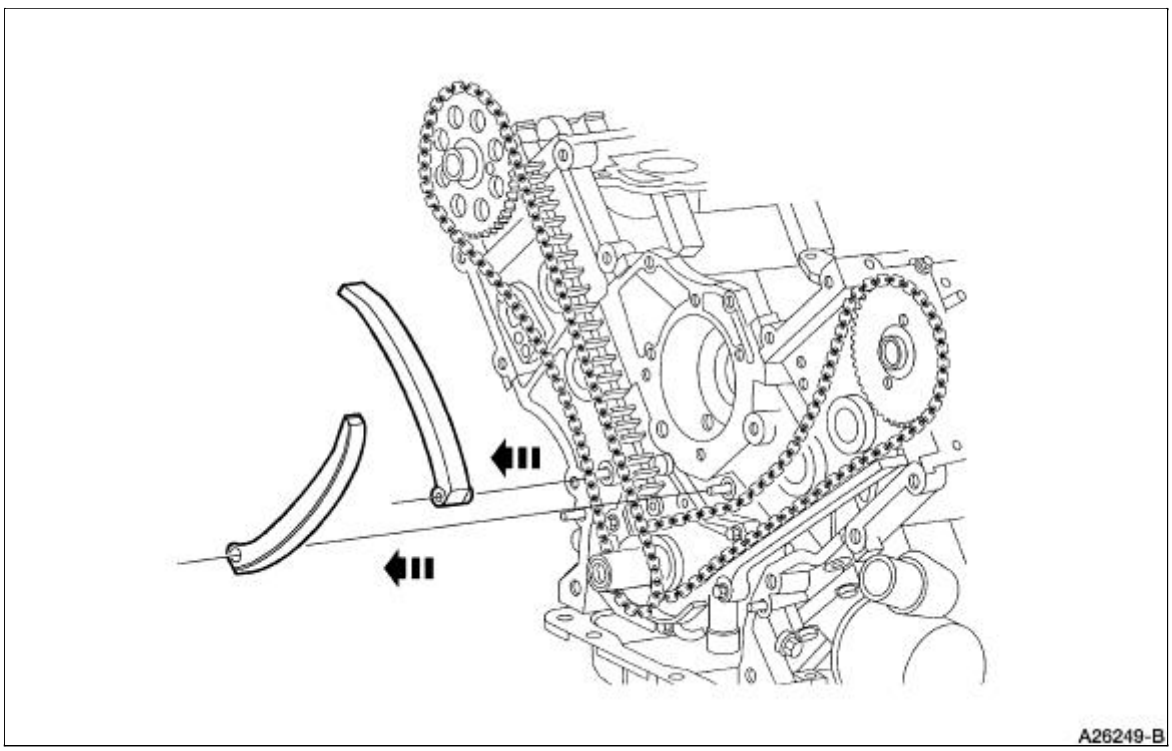
7. Remove the bolts and the LH timing chain tensioner.



8. Remove the bolts and the RH timing chain tensioner.

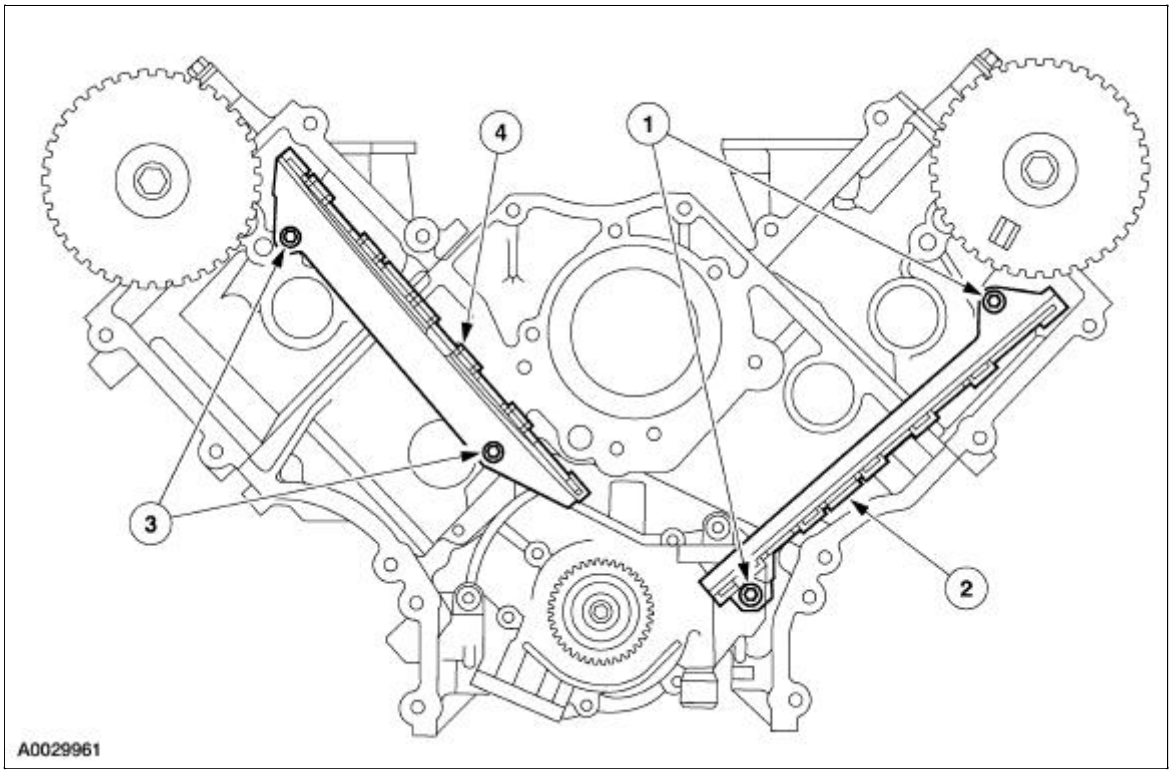


9. Remove the LH and the RH timing chain tensioner arm from the dowel pins.



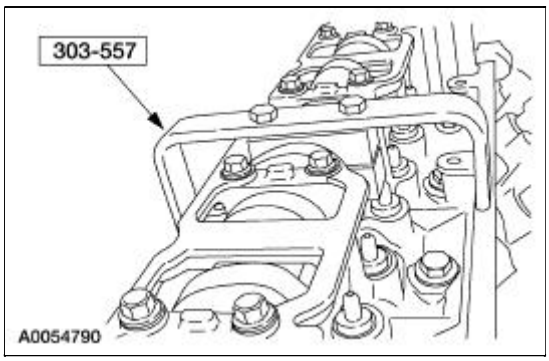
10. Remove the timing chains and the crankshaft sprocket.

11. Remove the timing chain guides.
    1. Remove the bolts.
    2. Remove the LH timing chain guide.
    3. Remove the bolts.
    4. Remove the RH timing chain guide.



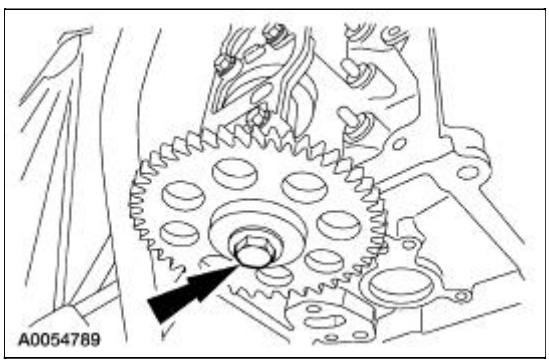
12. **NOTE:** RH shown, LH similar.

    Install the special tool.



13. **NOTE:** RH shown, LH similar.

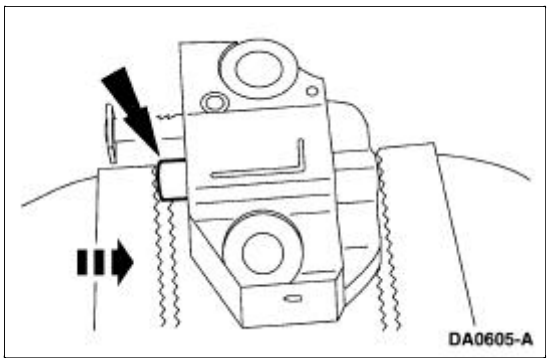
    Remove the bolt and the camshaft gear.



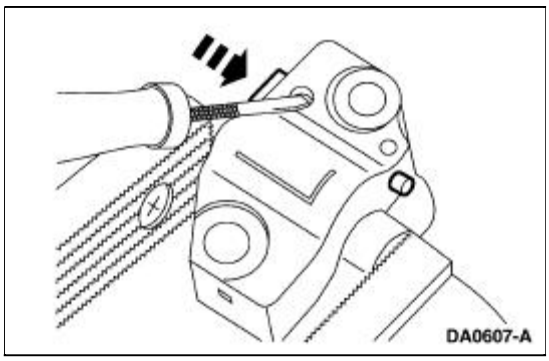
Installation

1. **CAUTION: The timing chain procedures must be followed exactly or damage to the valve and pistons will result.**

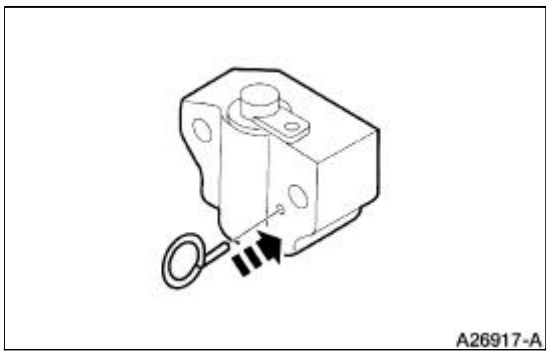
   Compress the tensioner plunger, using an edge of a vise.



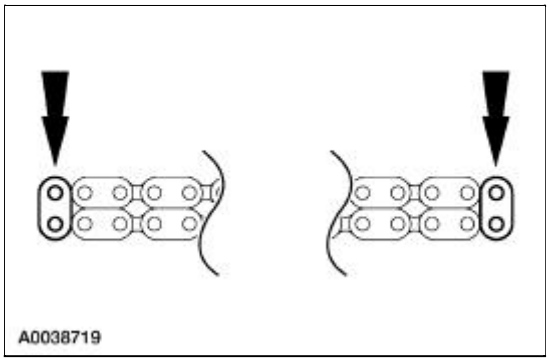
2. While holding the ratchet mechanism, push the ratchet arm back into the tensioner housing.



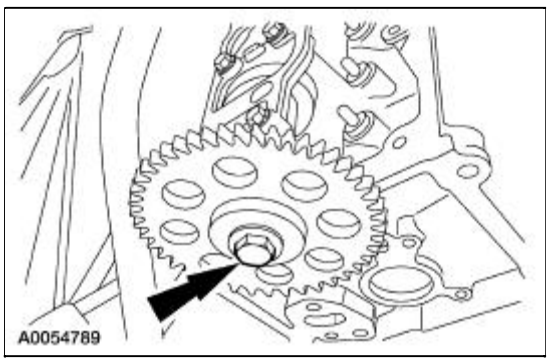
3. Install a paper clip into the hole in the tensioner housing to hold the ratchet assembly and plunger in during installation.



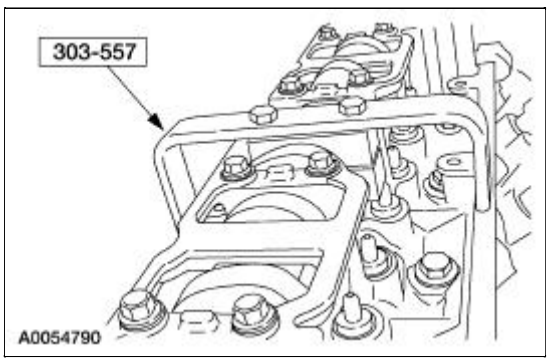
4. If the copper links are not visible, mark one link on one end and one link on the other end, and use as timing marks.



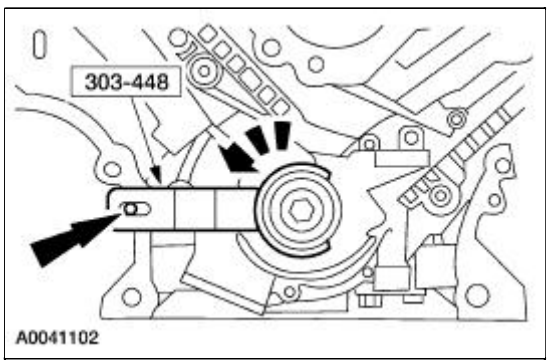
5. Install the camshaft sprockets and new bolts. Tighten the bolts in two stages.
    - Stage 1: Tighten the bolt to 40 Nm (30 lb-ft).
    - Stage 2: Tighten the bolt an additional 90 degrees (1/4 turn).



6. Remove the special tool.

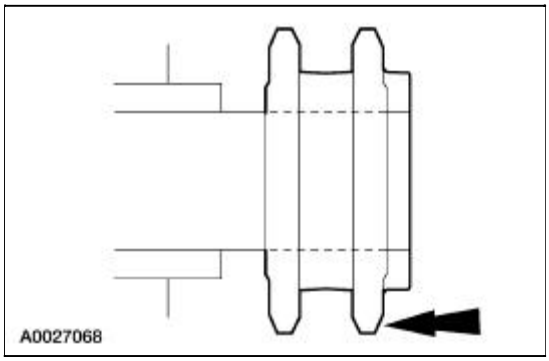


7. Using the special tool, position the crankshaft so the number one cylinder is at TDC.

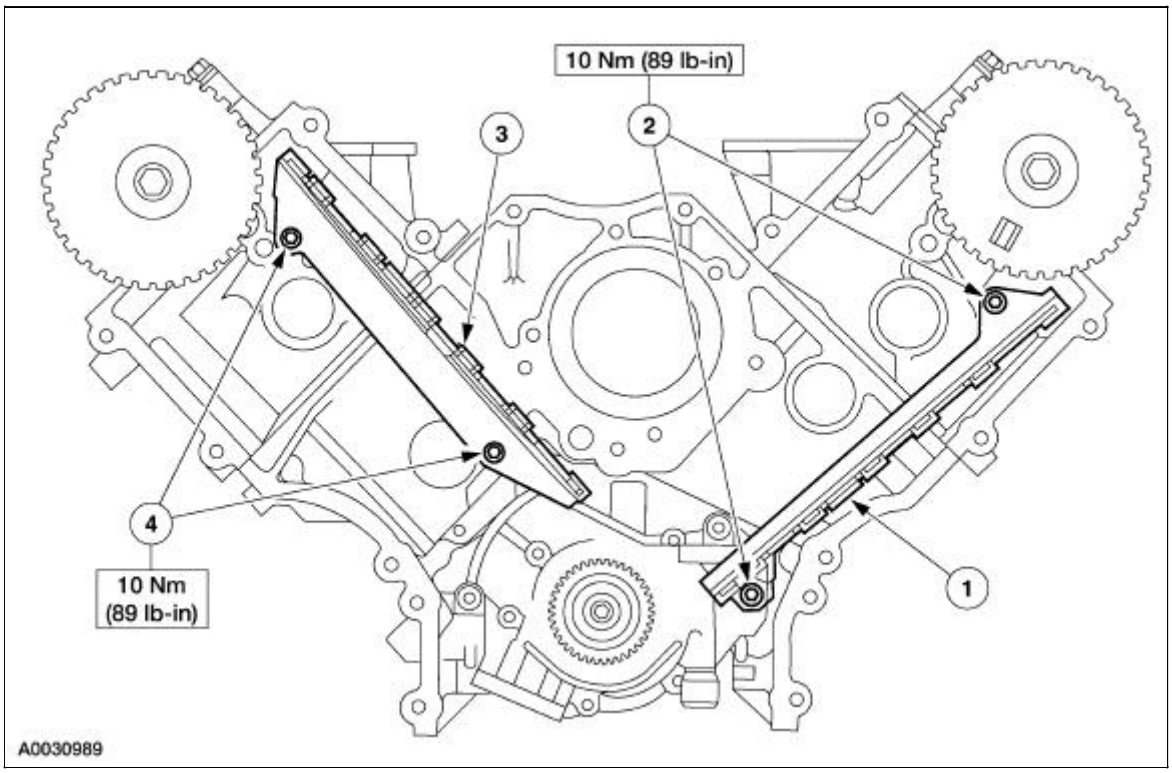


8. Remove the special tool.

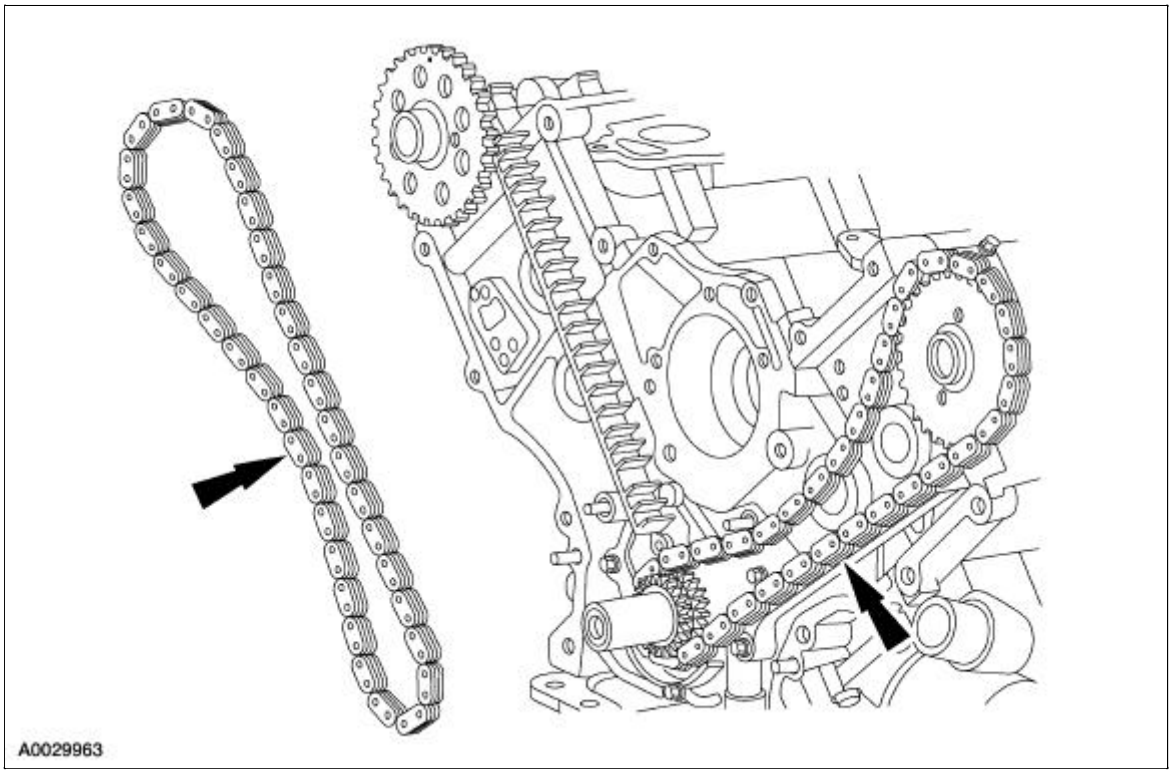
9. Install the crankshaft sprocket, making sure the flange faces forward.



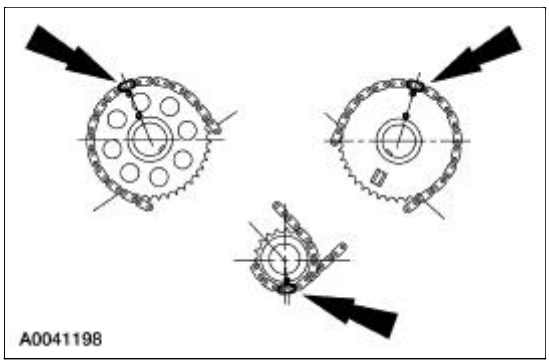
10. Install the timing chain guide.
    1. Position the LH timing chain guide.
    2. Install and tighten the LH bolts.
    3. Position the RH timing chain guide.
    4. Install and tighten the RH bolts.



11. Install the timing chains.
    - Install the LH (inner) timing chain on the crankshaft sprocket, aligning the copper link with the dot on the crankshaft sprocket.
    - Install the LH (inner) timing chain on the camshaft sprocket, aligning the copper link with the dot on the camshaft sprocket.
    - Install the RH (outer) timing chain on the crankshaft sprocket, aligning the copper link with the dot on the crankshaft sprocket.
    - Install the RH (outer) timing chain on the camshaft sprocket, aligning the copper link with the dot on the camshaft sprocket.

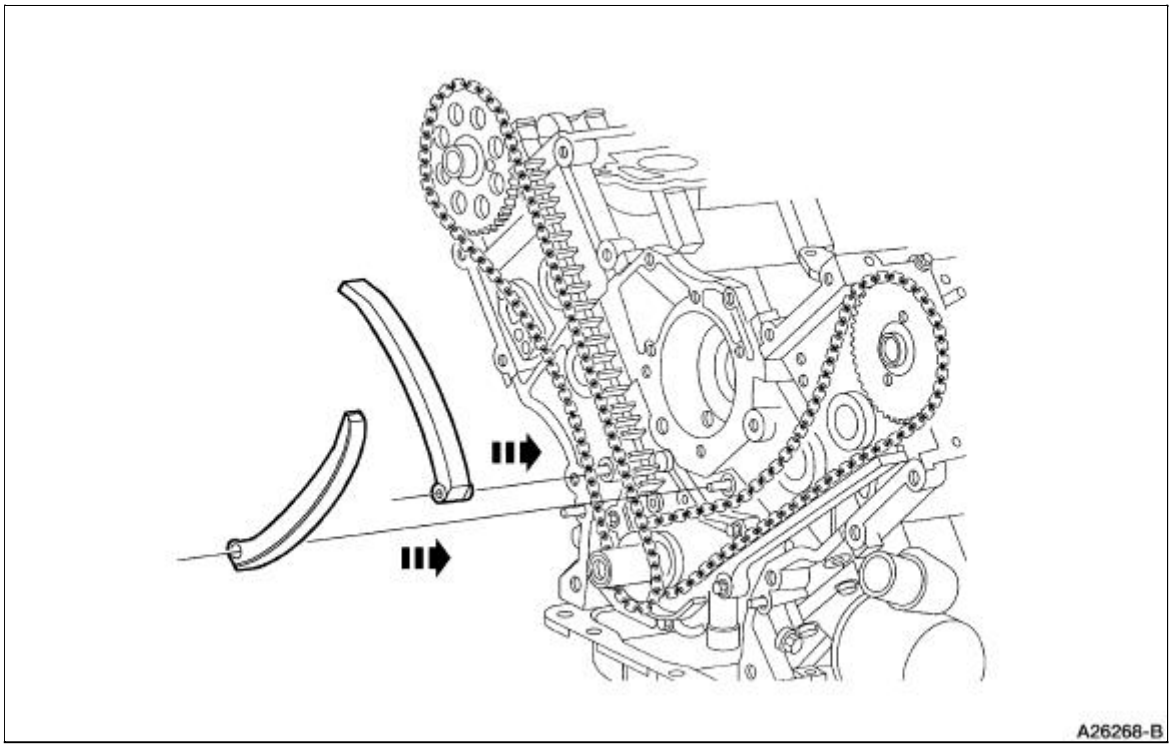


12. Make sure that the copper (marked) chain links are lined up with the dots on the crankshaft sprocket and the camshaft sprockets.

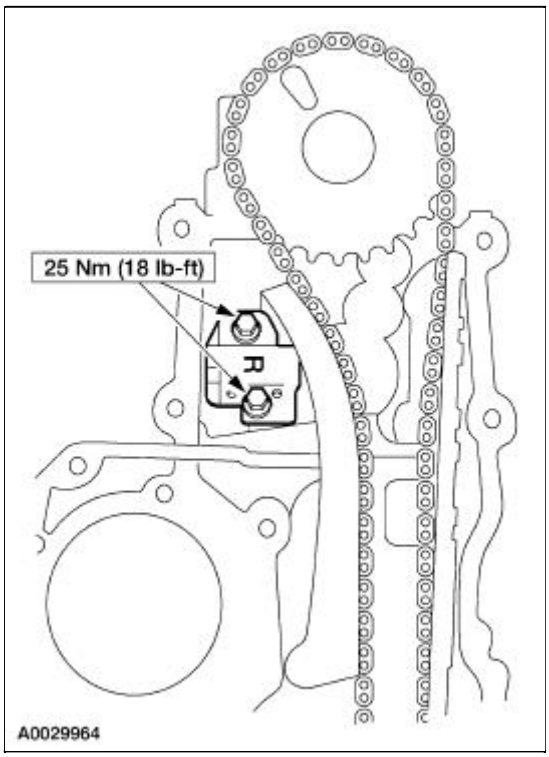


13. **NOTE:** The LH timing chain tensioner arm has a bump near the dowel hole, for identification.

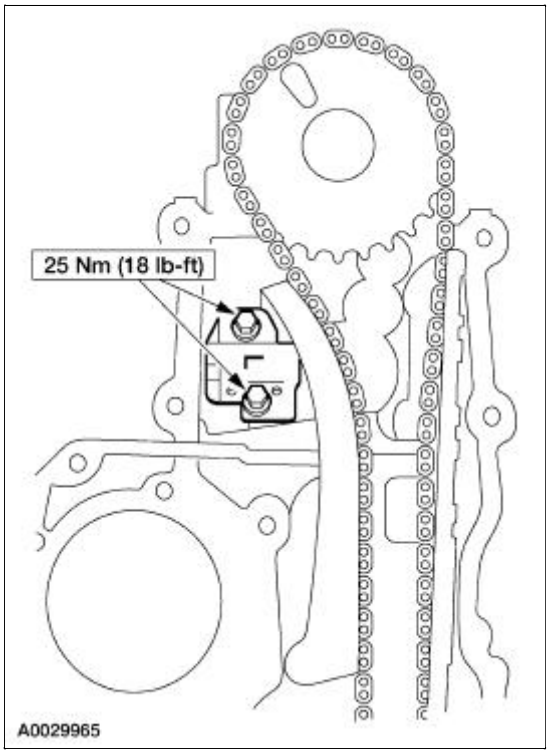
    Position the LH and the RH timing chain tensioner arm on the dowel pins.



14. Position the RH timing chain tensioner and install the bolts.



15. Position the LH timing chain tensioner and install the bolts.

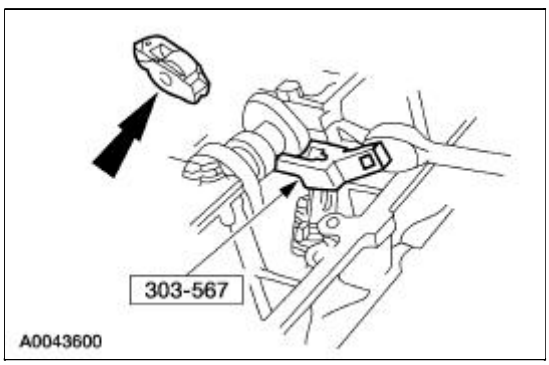


16. Remove the paper clip from the RH and the LH timing chain tensioners.

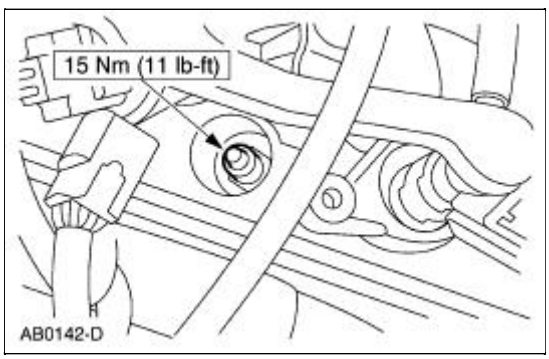
17. **NOTE:** Rotate the camshaft to the base circle of the camshaft lobe before installing the roller followers.

    NOTE: Keep all the roller followers in order when installing.

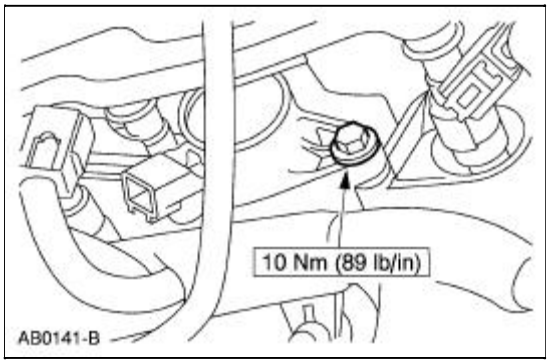
    Using the special tool, install the 16 roller followers.



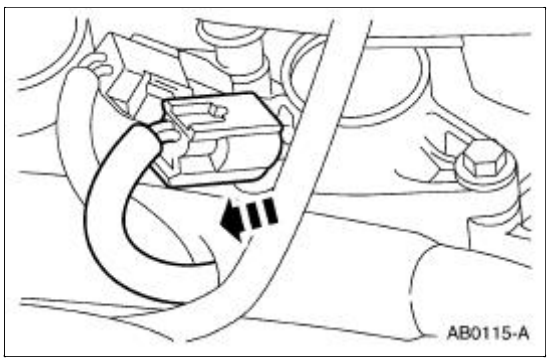
18. Install the eight spark plugs.



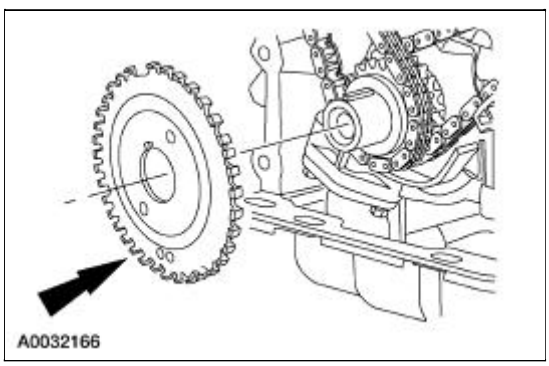
19. Install the eight ignition coils and bolts.



20. Connect the eight ignition coil electrical connectors.



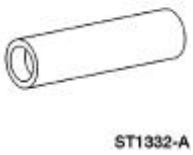
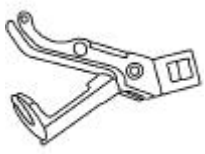
21. Install the crankshaft sensor ring on the crankshaft.



22. Install the engine front cover. For additional information, refer to Engine Front Cover in this section.

Valve Seals

Special Tool(s)

ST1718-A	Valve Spring Compressor 303-452 (T93P-6565-AR)
 ST1332-A	Valve Stem Seal Replacer 303-383 (T91P-6571-A)
 ST1693-A	Compressor, Valve Spring (Exhaust) 303-567 (T97P- 6565-AH)

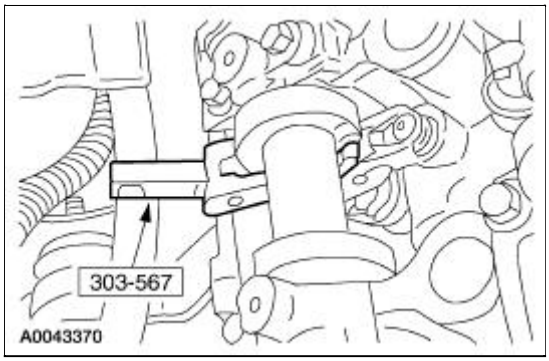
Material

Item	Specification
Super Premium SAE 5W-20 Motor Oil XO-5W20-QSP	WSS-M2C153-H

Removal and Installation

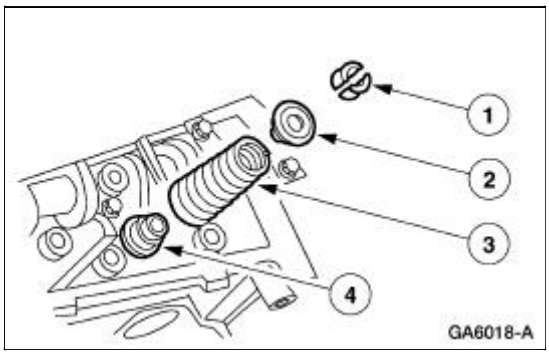
1. Remove the roller followers. For additional information, refer to Camshaft Roller Follower in this section.
2. Remove the spark plug (12405) from the applicable cylinder.
3. Position the piston (6102) of the cylinder being serviced at the bottom of the stroke.
4. **CAUTION: If air pressure has forced the piston to the bottom of the cylinder, any loss of air pressure will allow the valve to fall into the cylinder. If air pressure must be removed, support the valve prior to removal.**

   Use compressed air in the cylinder to hold both valves in position.
5. Using the special tool, compress the valve spring (6513).



6. **NOTE:** Valve stem seals should be visually inspected if not installing new seals.

   Remove the valve stem seals.
   1. Remove the valve spring retainer keys.
   2. Remove the valve spring retainers.
   3. Remove the valve springs.
   4. Remove the valve stem seals.



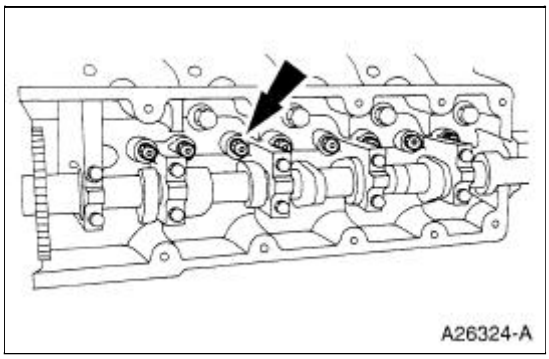
7. **NOTE:** Lubricate the lip of the new seal with clean engine oil prior to installation.

   To install, reverse the removal procedure.

Hydraulic Lash Adjuster

Removal and Installation

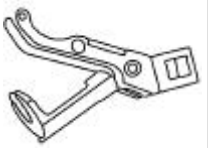
1. Remove the roller followers. For additional information, refer to Camshaft Roller Follower in this section.
2. Remove the eight hydraulic lash adjusters.



3. Inspect the lash adjusters. For additional information, refer to Section 303-00 .
4. To install, reverse the removal procedure.

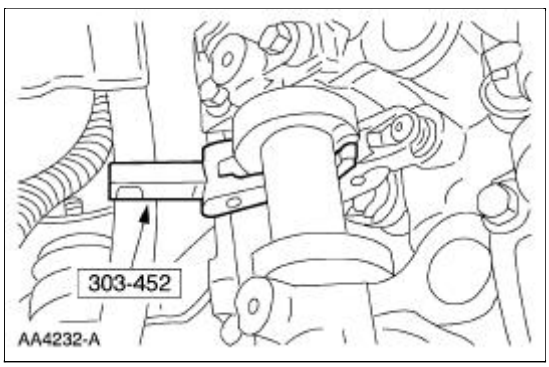
Camshaft Roller Follower

Special Tool(s)

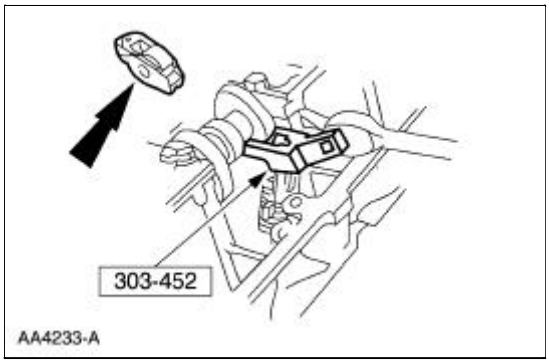
ST1718-A	Compressor, Valve Spring (Intake) 303-452 (T93P-6565-AR)
 ST1693-A	Compressor, Valve Spring (Exhaust) 303-567 (T97P-6565-AH)

Removal

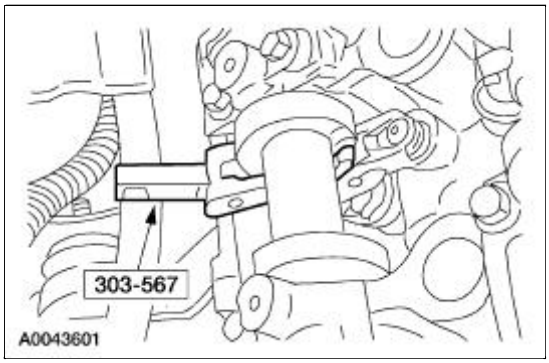
1. Remove the valve cover. For additional information, refer to Valve Cover LH or Valve Cover RH in this section.
2. Position the piston of the cylinder being serviced at the bottom of the stroke and the camshaft lobe at base circle.
3. Using the special tool compress the intake valve spring.



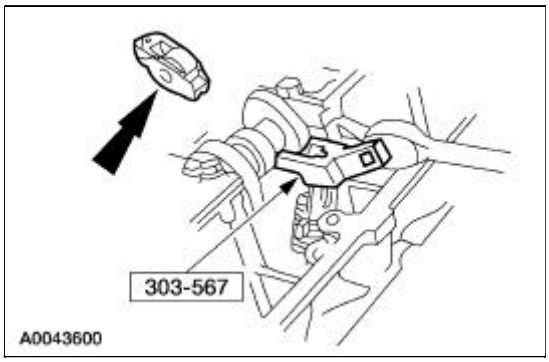
4. Remove the roller follower from the intake valve.



5. Using the special tool compress the exhaust valve spring.



6. Remove the camshaft roller follower from the exhaust valve.



7. Repeat Steps 2, 3 and 4 to remove all the necessary roller followers. Inspect roller finger followers and camshafts. For additional information, refer to Section 303-00 .

Installation

1. To install, reverse the removal procedure.

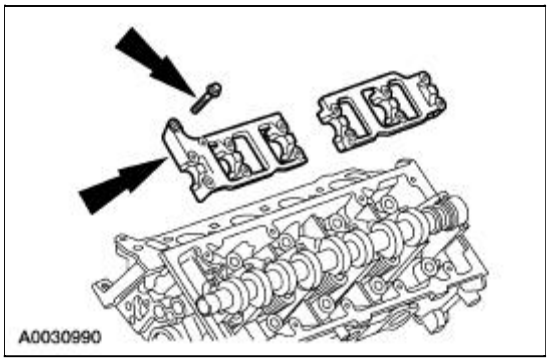
Camshaft

Removal and Installation

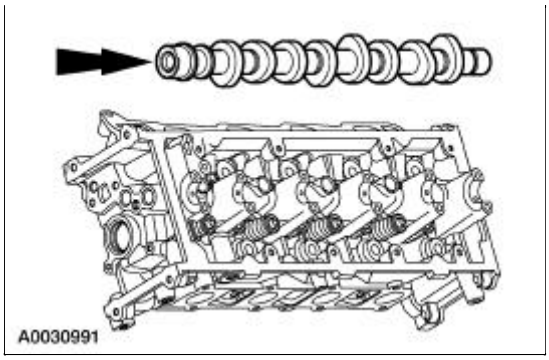
1. Remove the timing chains. For additional information, refer to Timing Drive Components in this section.

2. Remove the roller followers. For additional information, refer to Camshaft Roller Follower in this section.

3. Remove the bolts and camshaft bearing caps.

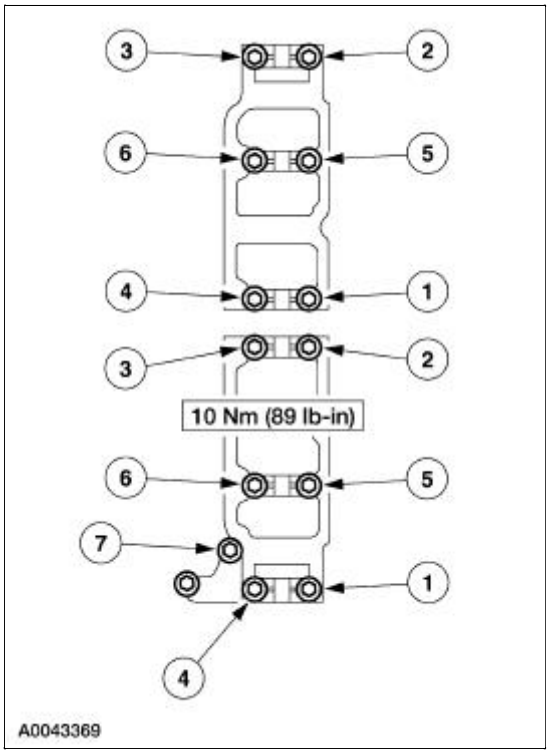


4. Remove the camshaft.



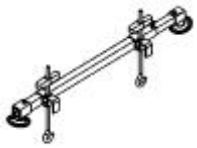
5. **NOTE:** Tighten the camshaft bearing cap bolts in the sequence shown.

   To install, reverse the removal procedure.


3
2
6
5
4
1
3
2
10 Nm (89 lb-in)
6
5
7
1
4
A0043369

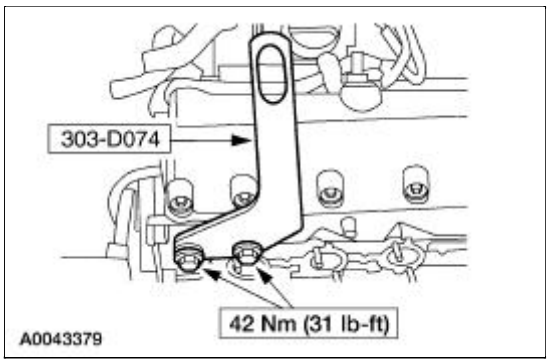
Exhaust Manifold RH

Special Tool(s)

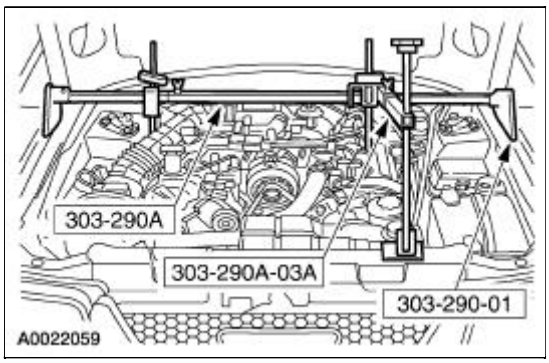
ST1603-A	Lifting Bracket, Engine 303-D088 (D93P-6001-A2)
 ST2363-A	Support Bar, Engine 303-290-A

Removal and Installation

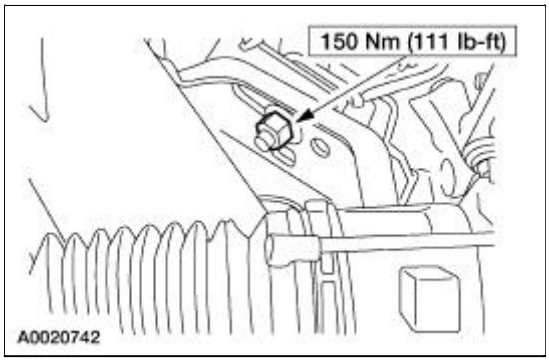
1. Install the special tool.



2. Install the special tools.

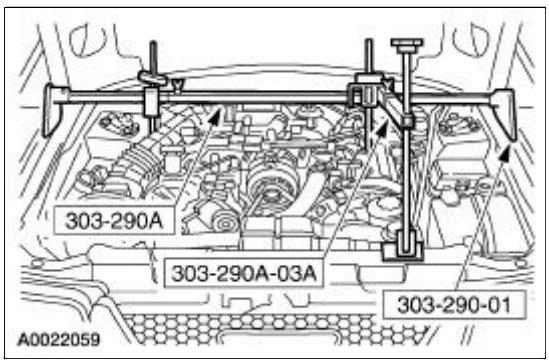


3. Raise and support the vehicle. For additional information, refer to Section 100-02 .
4. Remove the LH and RH side engine mount nuts.



5. Lower the vehicle.

6. Using the special tools, raise the engine.



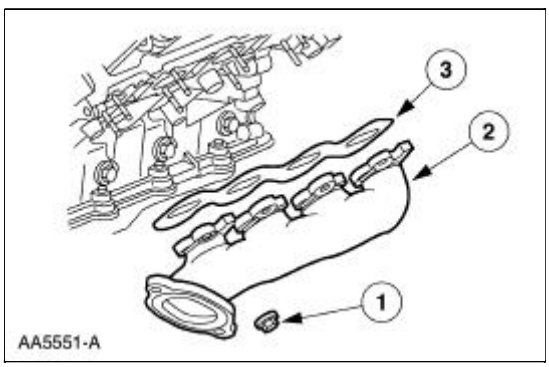
7. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .

8. Raise and support the vehicle.

9. Remove the starter motor. For additional information, refer to Section 303-06 .

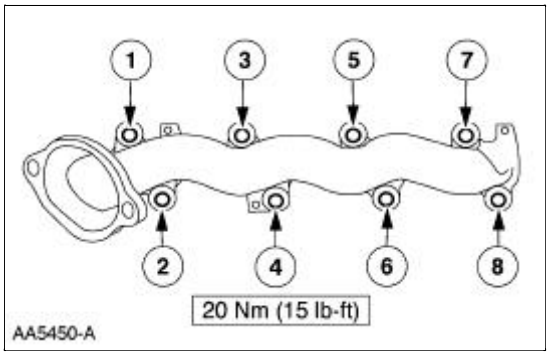
10. Separate the exhaust at the exhaust manifold. For additional information, refer to Section 309-00 .

11. Remove the exhaust manifold.
    1. Remove the exhaust manifold nuts.
    2. Remove the exhaust manifold.
    3. Remove the exhaust manifold gasket and discard.



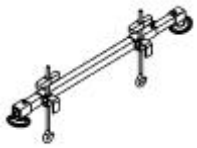
12. **NOTE:** Tighten the exhaust manifold nuts in the sequence shown.

    To install, reverse the removal procedure.


1
3
5
7
2
4
6
8
20 Nm (15 lb-ft)
AA5450-A

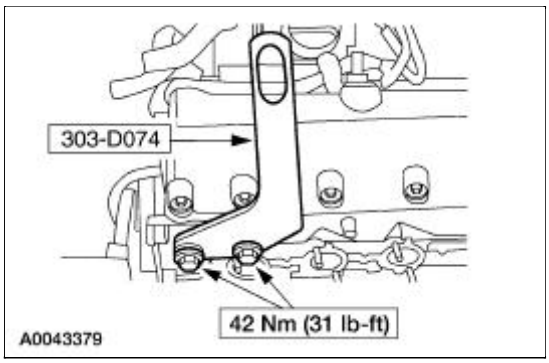
Exhaust Manifold LH

Special Tool(s)

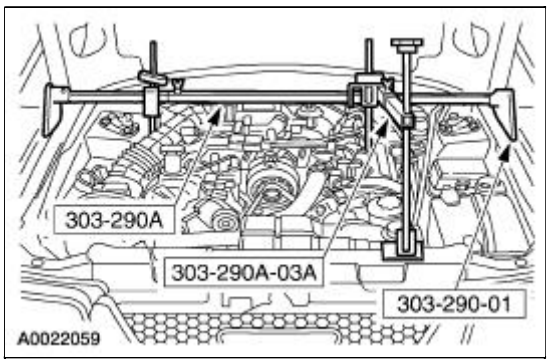
ST1603-A	Lifting Bracket, Engine 303-D088 (D93P-6001-A2)
 ST2363-A	Support Bar, Engine 303-290-A

Removal and Installation

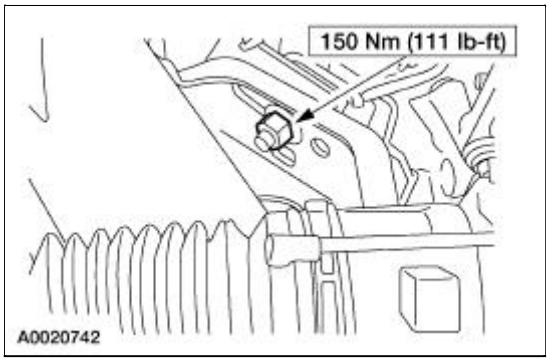
1. Install the special tool.



2. Install the special tools.

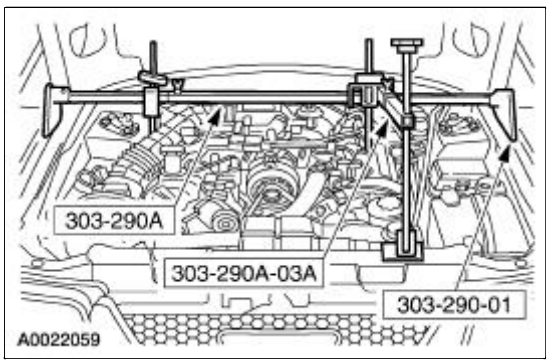


3. Raise and support the vehicle. For additional information, refer to Section 100-02 .
4. Remove the LH and RH side engine mount nuts.



5. Lower the vehicle.

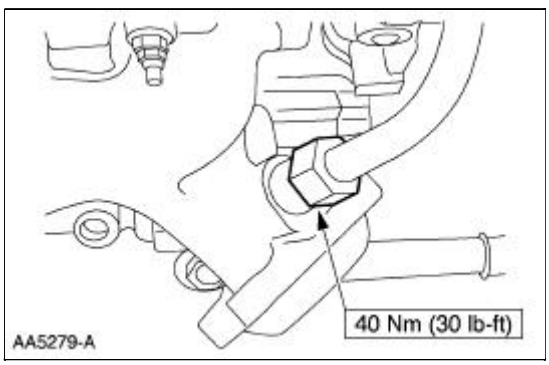
6. Using the special tools, raise the engine.



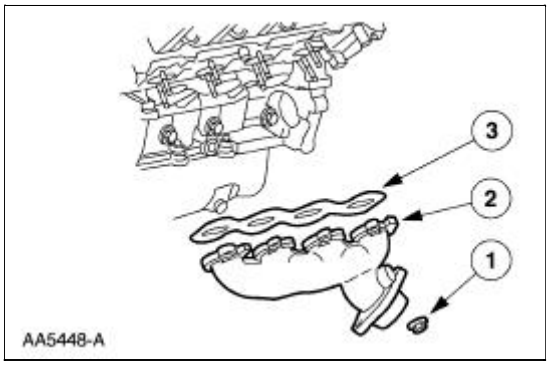
7. Raise the vehicle.

8. Separate the exhaust at the exhaust manifold. For additional information, refer to Section 309-00 .

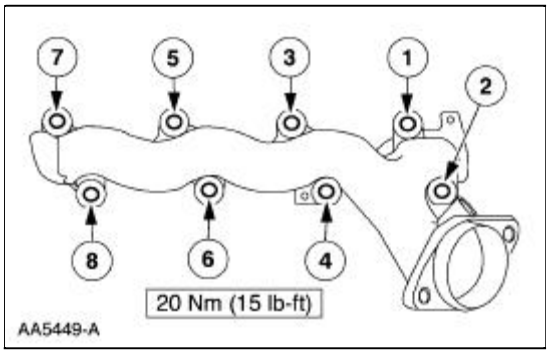
9. Disconnect the exhaust gas recirculation (EGR) tube at the exhaust manifold.



10. Remove the exhaust manifold.
    1. Remove the exhaust manifold nuts.
    2. Remove the exhaust manifold.
    3. Remove the exhaust manifold gasket.



11. To install, reverse the removal procedure.
    1. Tighten the exhaust manifold nuts in the sequence shown.



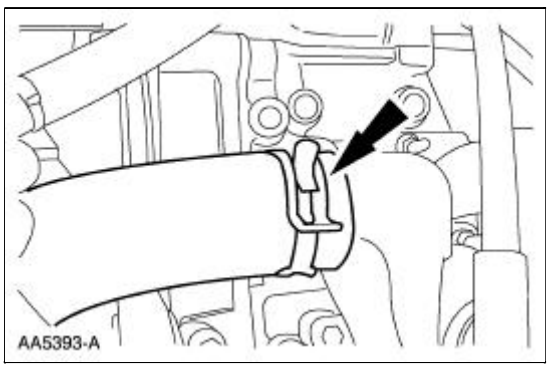
Oil Filter Adapter

Material

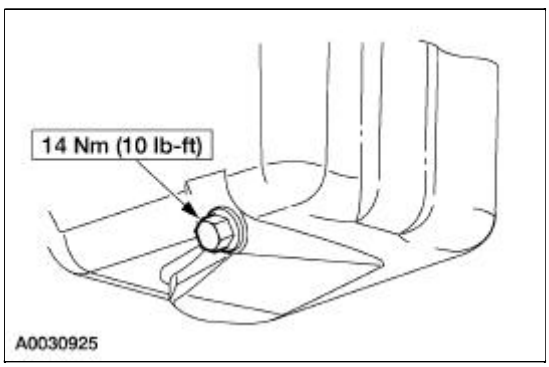
Item	Specification
Super Premium SAE 5W-20 Motor Oil XO-5W20 QSP or equivalent	WSS-M2C153-H
Premium Engine Coolant VC-4A (In Canada CXC-10; In Oregon VC-5) or equivalent	ESE-M97B44-A

Removal and Installation

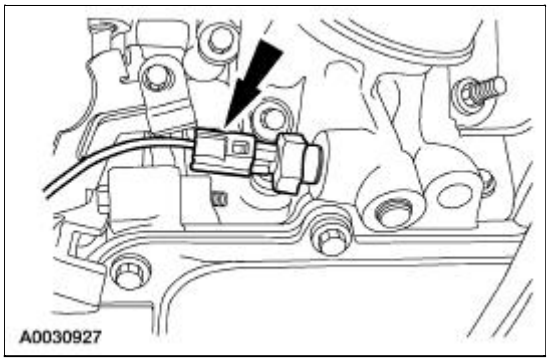
1. Drain the cooling system. For additional information, refer to Section 303-03A or Section 303-03B .
2. Disconnect the lower radiator hose.



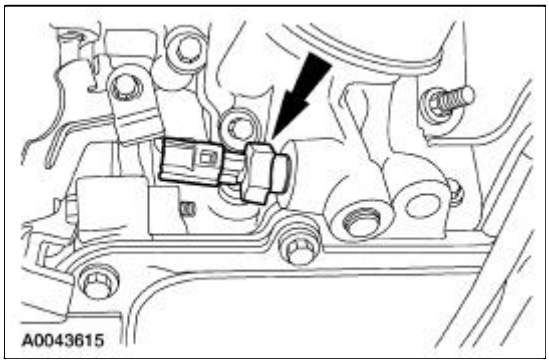
3. Raise and support the vehicle. For additional information, refer to Section 100-02 .
4. Drain the engine oil.



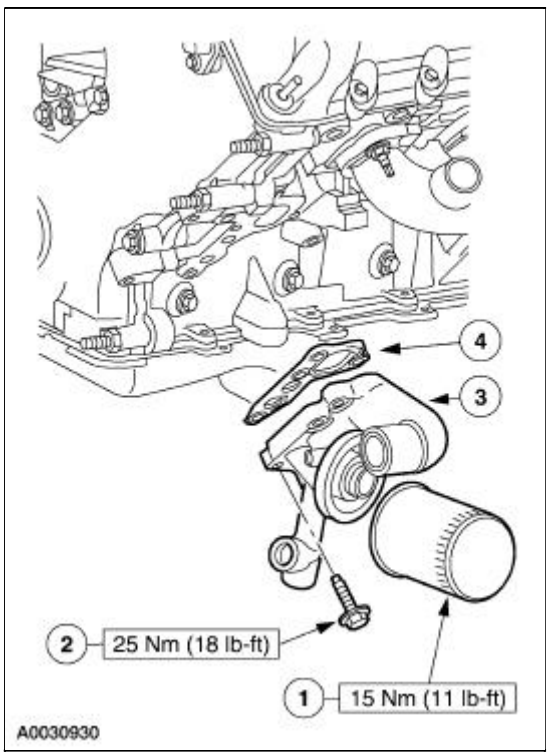
5. Disconnect the oil pressure sensor electrical connector.



6. Remove the oil pressure sensor.



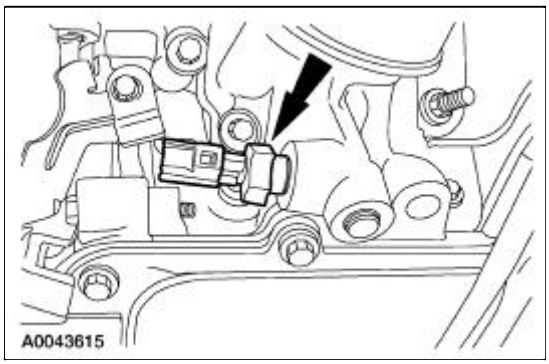
7. Remove the oil filter adapter (6881).
    1. Remove the oil bypass filter.
    2. Remove the bolts.
    3. Remove the oil filter adapter.
    4. Clean and inspect the sealing surfaces.



8. To install, reverse the removal procedure.

9. Tighten the oil pressure sensor in two stages.

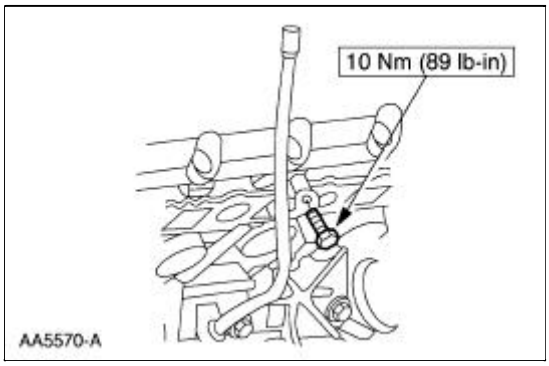
- Tighten to 14Nm(10 lb-ft).
- Tighten an additional 180°



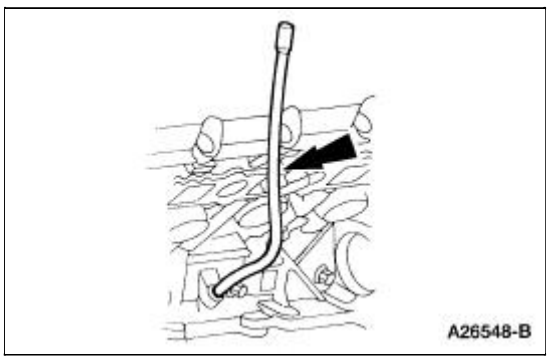
Oil Level Indicator and Tube

Removal and Installation

1. Remove the oil level indicator.
2. Remove the LH exhaust manifold. For additional information, refer to Exhaust Manifold LH in this section.
3. Remove the bolt.



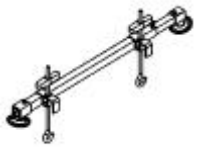
4. Remove the oil level indicator tube.



5. To install, reverse the removal procedure.
   - Install a new oil level indicator tube seal.

Oil Pan

Special Tool(s)

ST1352-A	Compressor, Coil Spring 204-D001 (D78P-5310-A)
 ST2363-A	Support Bar, Engine 303-290-A
ST1604-A	Lifting Bracket, Engine 303-D087 (D93P-6001-A1)
ST1603-A	Lifting Bracket, Engine 303-D088 (D93P-6001-A2)

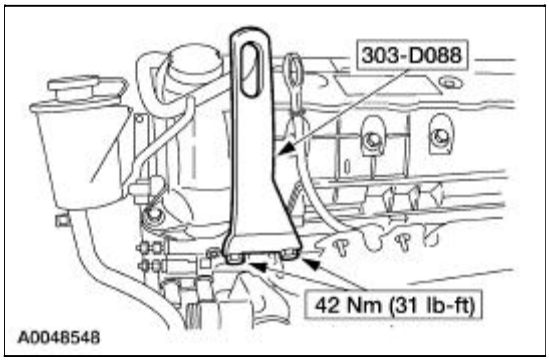
Material

Item	Specification
Metal Surface Cleaner F4ZA-19A536-RA or equivalent	WSE-M5B392-A
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4
Super Premium SAE 5W-20 Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

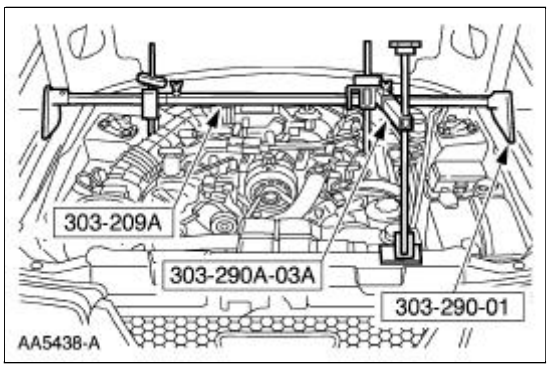
Removal

1. Disconnect the battery ground cable.
2. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12 .
3. Remove the radiator sight shield.

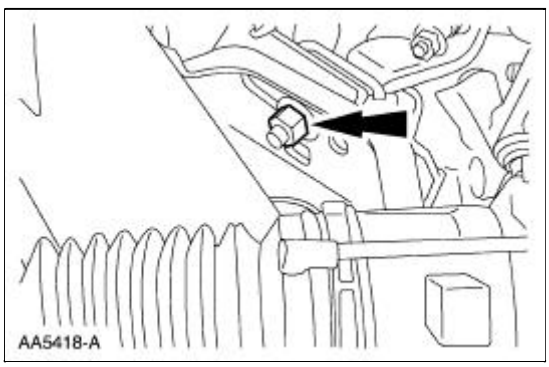
4. Install the special tool.



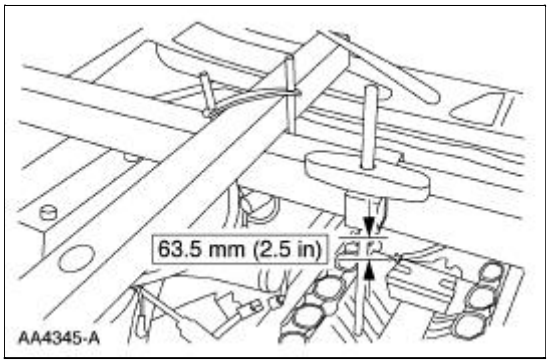
5. Using the special tools, support the engine.



6. Raise and support the vehicle. For additional information, refer to Section 100-02 .
7. Remove the two engine mount nuts.

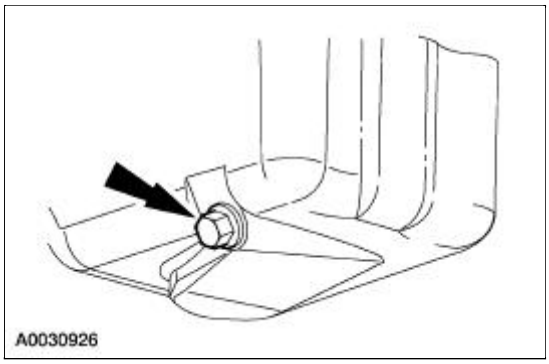


8. Lower the vehicle.
9. Using the special tool, raise the engine.

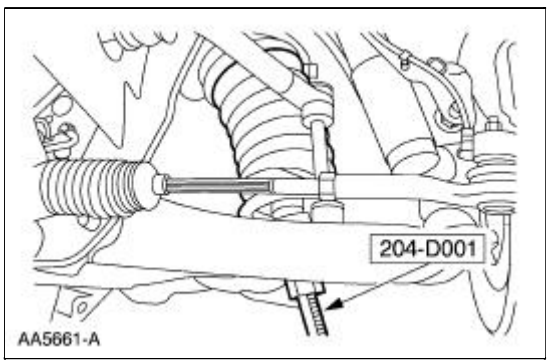


10. Raise and support the vehicle. For additional information, refer to Section 100-02 .

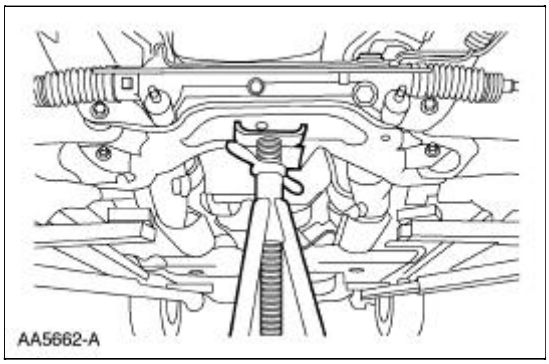
11. Drain the engine oil.
    - Remove the oil pan drain plug.



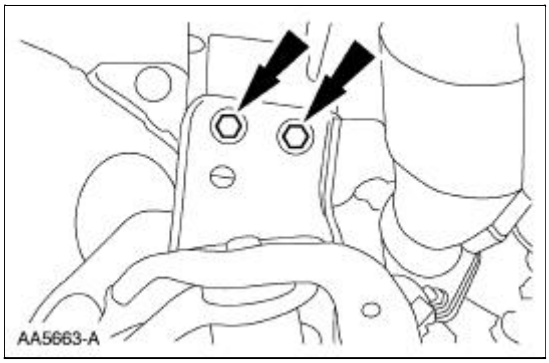
12. Using the special tool, compress the front coil springs.



13. Position a safety stand.

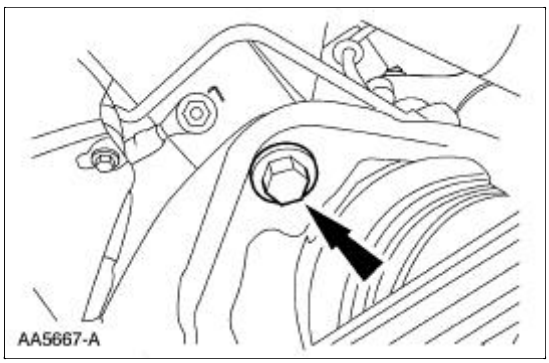


14. Remove the four engine mount bolts.

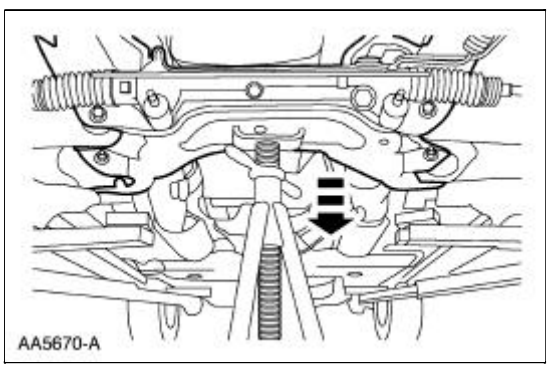


15. **NOTE:** Do not completely remove the bolts.

    Loosen the front subframe bolts.

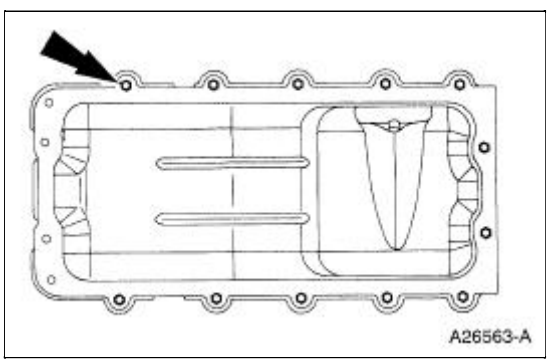


16. Lower the front subframe.



17. **NOTE:** Be careful when removing the oil pan gasket. It may be reusable. Inspect the oil pan gasket for damage.

    Remove the oil pan and gasket.



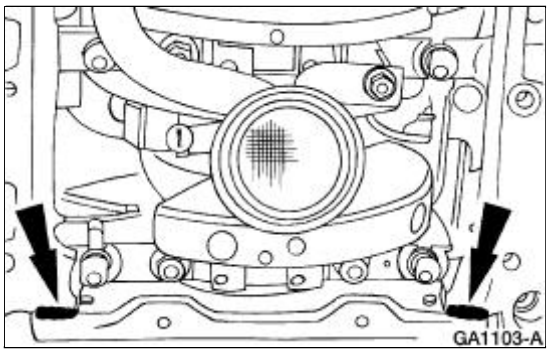
Installation

1. **CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.**

   Clean and inspect the mating surfaces.

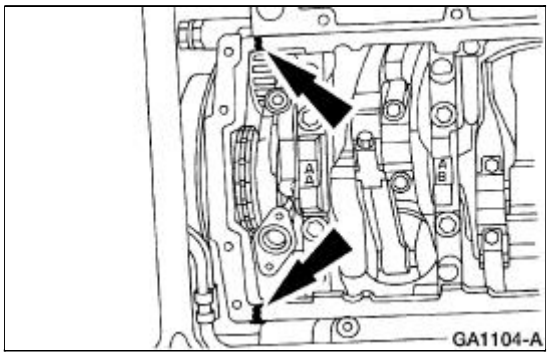
2. **NOTE:** If the oil pan is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can result in future oil leakage.

   Apply the silicone gasket and sealant at the rear oil seal retainer-to-cylinder block sealing surface.

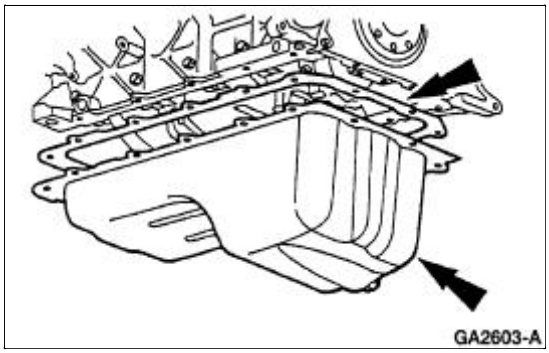


3. **NOTE:** If the oil pan is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can result in future oil leakage.

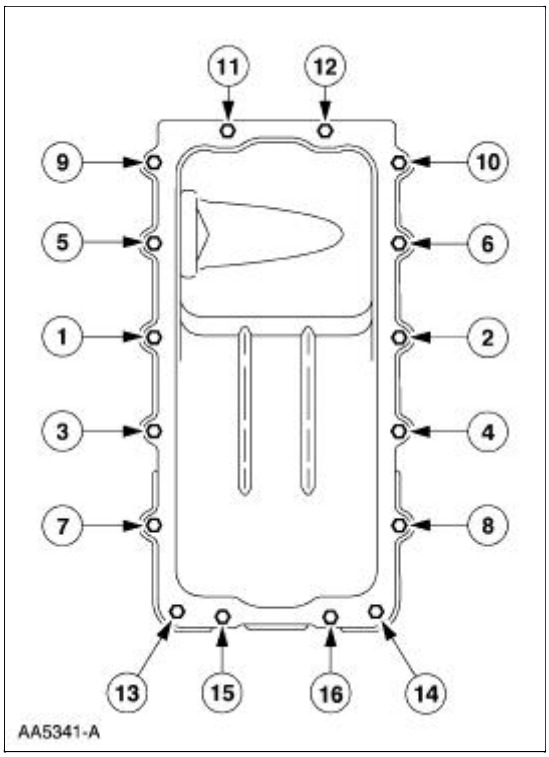
   Apply the silicone gasket and sealant at the engine front cover-to-cylinder block mating surface.



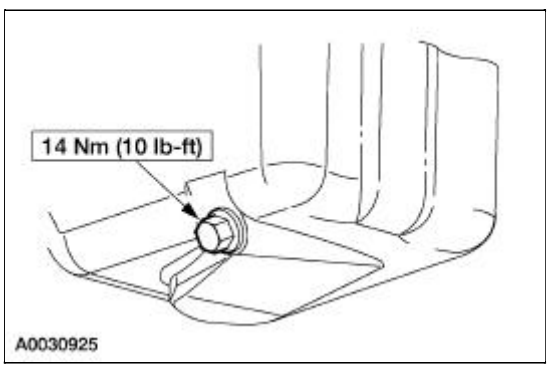
4. Install the oil pan and gasket and loosely install the bolts.



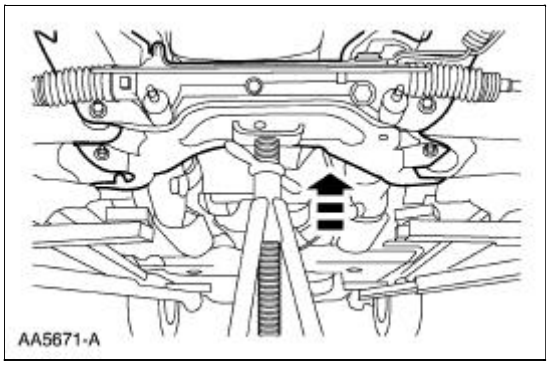
5. Tighten the bolts in the sequence shown in three stages.
    - Stage 1: Tighten to 2 Nm (18 lb-in).
    - Stage 2: Tighten to 20 Nm (15 lb-ft).
    - Stage 3: Tighten an additional 60 degrees.



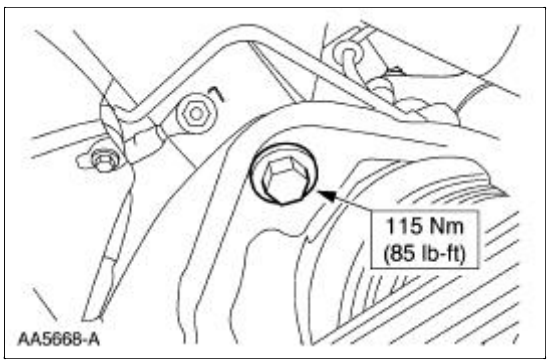
6. Install the oil pan drain plug.



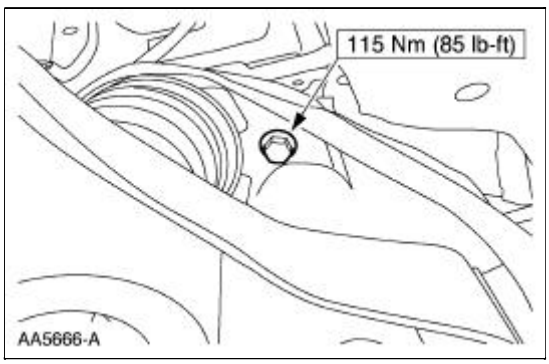
7. Raise the front subframe into position.



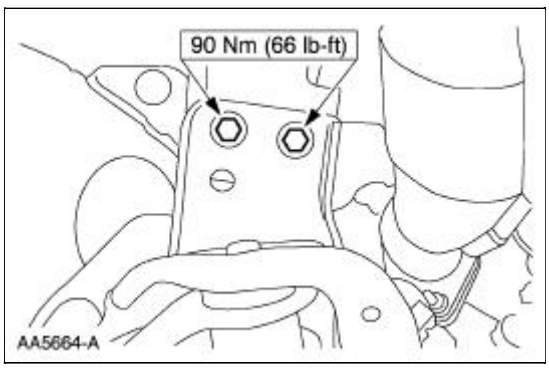
8. Install the two upper subframe bolts.



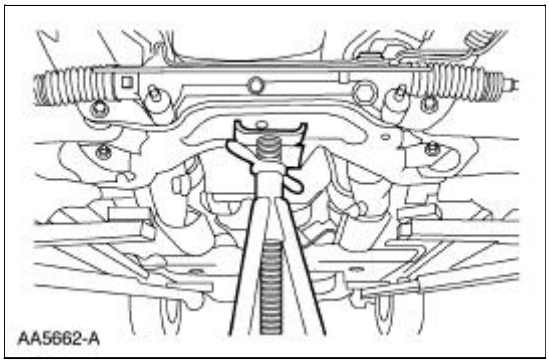
9. Install the two lower subframe bolts.



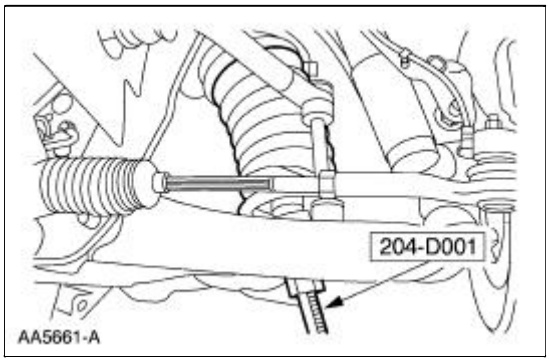
10. Install the engine mount bolts.



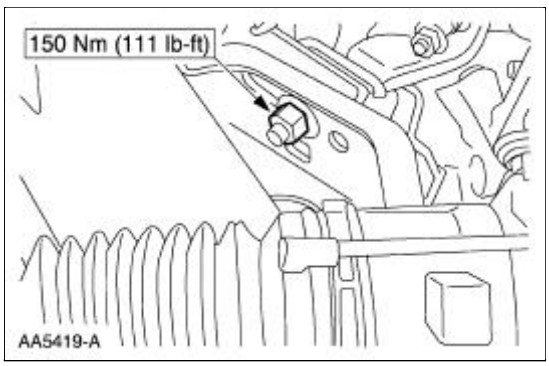
11. Position the safety stand aside.



12. Using the special tool, release the tension from the front coil springs and remove the special tool.

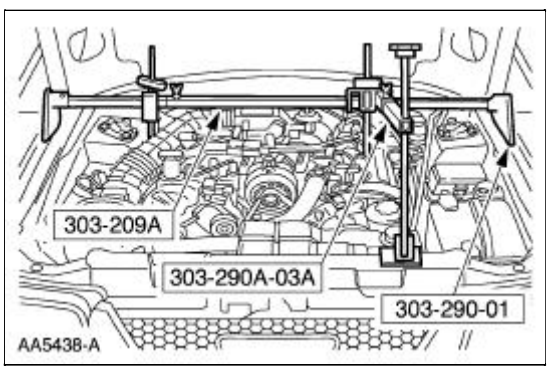


13. Install the engine mount nuts.

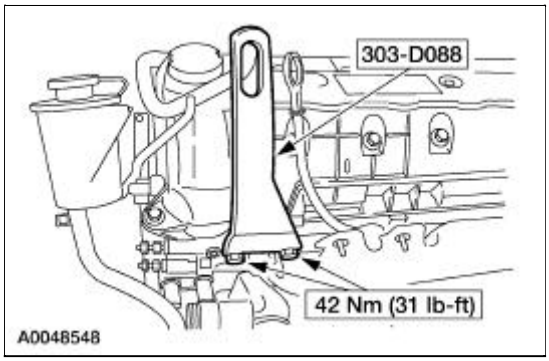


14. Lower the vehicle.

15. Using the special tools, lower the engine and remove the special tool.



16. Remove the special tool.



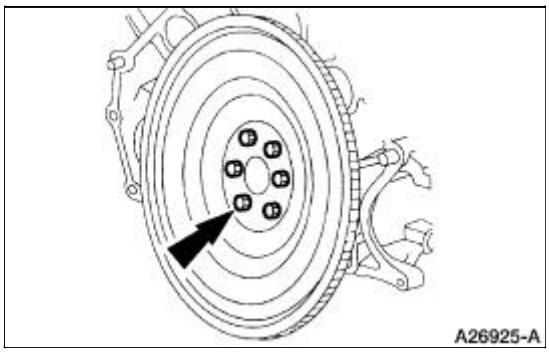
17. Fill the engine crankcase with clean engine oil.

Flywheel

Removal

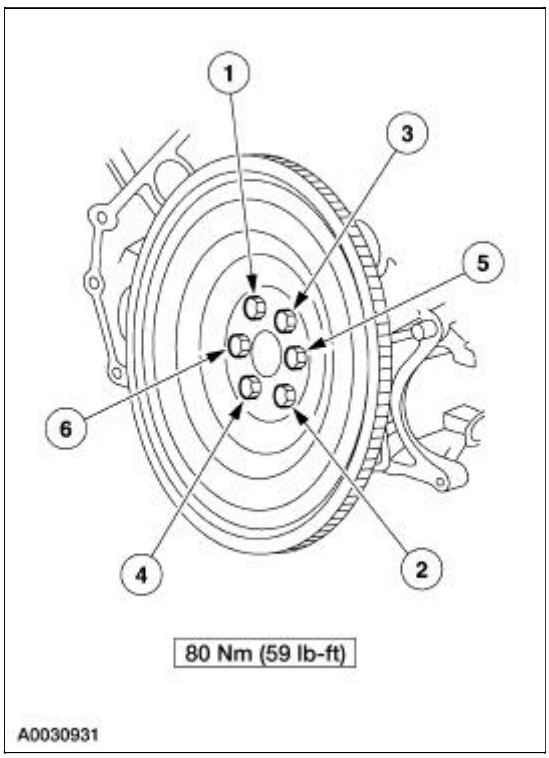
1. Remove the clutch components. For additional information, refer to Section 308-03A or Section 308-03B .

2. Remove the bolts and the flywheel.



Installation

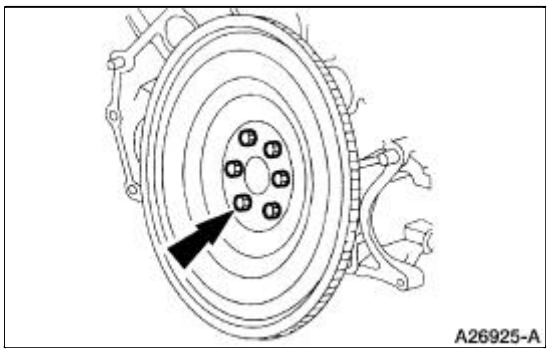
1. To install, reverse the removal procedure.
    - Tighten the bolts in the sequence shown.



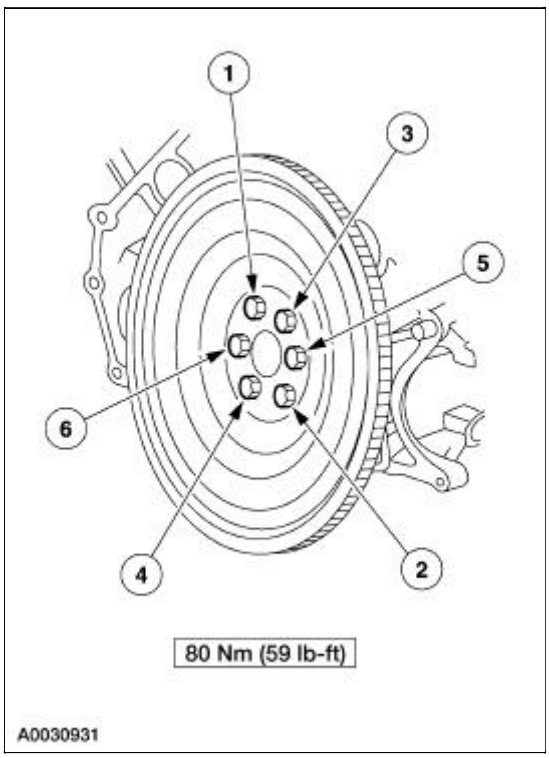
Flexplate

Removal and Installation

1. Remove the transmission. For additional information, refer to Section 307-01 .
2. Remove the six bolts retaining the flexplate to crankshaft, and remove the flexplate.

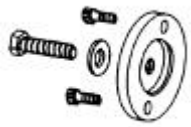
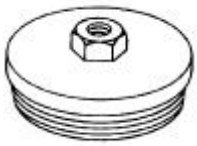
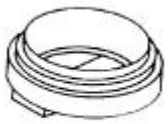


3. To install, reverse the removal procedure.
   - Tighten the bolts in the sequence shown



Crankshaft Rear Oil Seal

Special Tool(s)

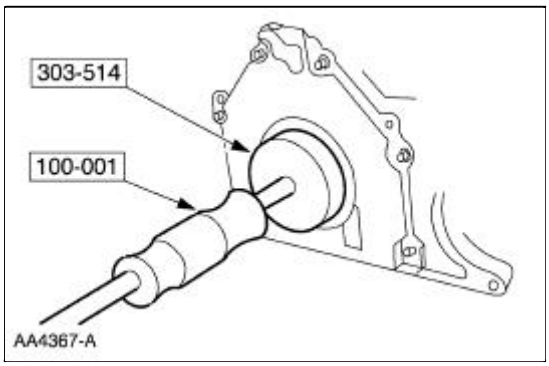
 ST1480-A	Installer, Crankshaft Rear Oil Seal 303-518 (T95P-6701-DH)
 ST1382-A	Remover, Crankshaft Rear Oil Seal 303-519 (T95P-6701-EH)
 ST1479-A	Installer, Crankshaft Rear Oil Seal 303-516 (T95P-6701-BH)
ST1481-A	Remover, Crankshaft Rear Oil Slinger 303-514 (T95P-6701-AH)
ST1482-A	Installer, Crankshaft Rear Oil Slinger 303-517 (T95P-6701-CH)
ST1185-A	Impact Slide Hammer 100-001 (T50T-100-A)

Material

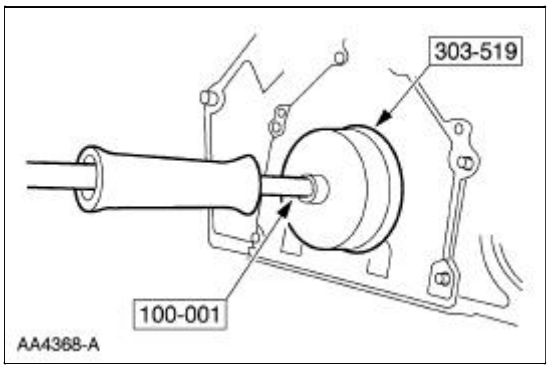
Item	Specification
Super Premium SAE 5W-20 Engine Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

1. Remove the flywheel. For additional information, refer to Flywheel in this section.
2. Using the special tools, remove the crankshaft oil slinger.

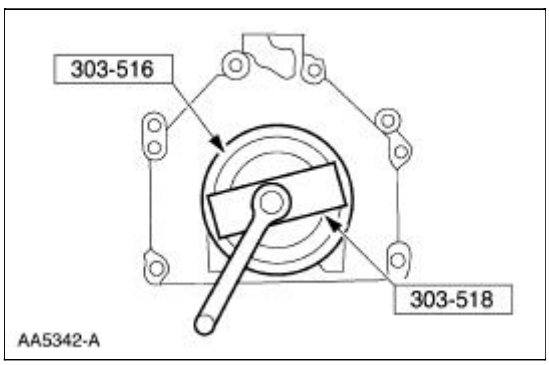


3. Using the special tools, remove the crankshaft rear oil seal (6701).

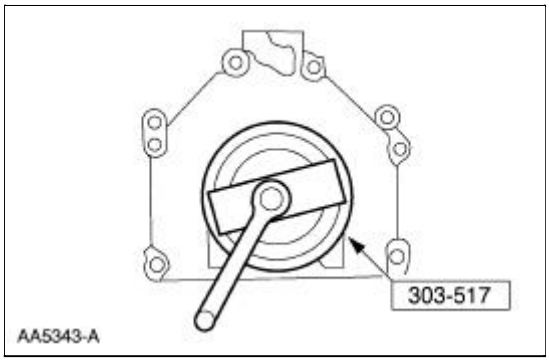


Installation

1. Using the special tools, install the crankshaft rear oil seal.
   - Lubricate the oil seal using clean engine oil.



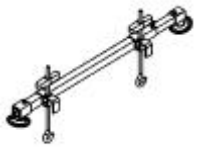
2. Using the special tool, install the crankshaft oil slinger.



3. Install the flywheel. For additional information, refer to Flywheel in this section.

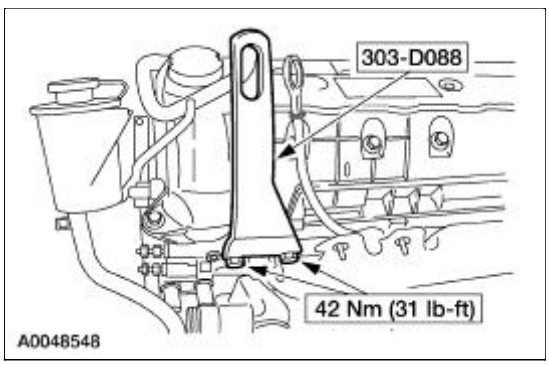
Engine Mount RH

Special Tool(s)

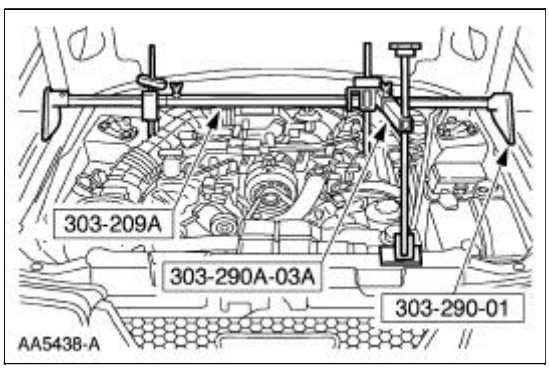
ST1603-A	Lifting Bracket, Engine 303-D088 (D93P-6001-A2)
 ST2363-A	Support Bar, Engine 303-290-A

Removal

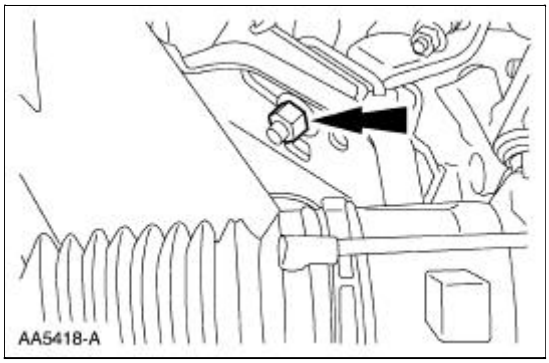
1. Install the special tool.



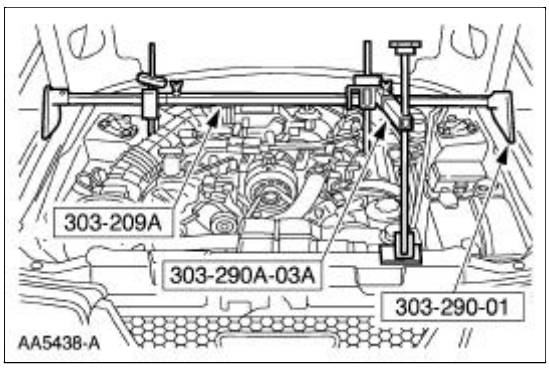
2. Install the special tools.



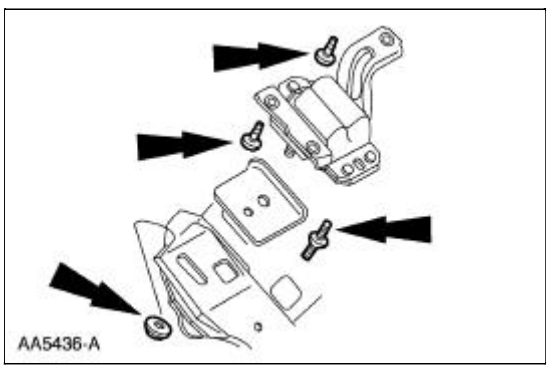
3. Remove the starter. For additional information, refer to Section 303-06 .
4. Remove the two engine mount nuts.



5. Lower the vehicle.
6. Using the special tools, raise the engine.

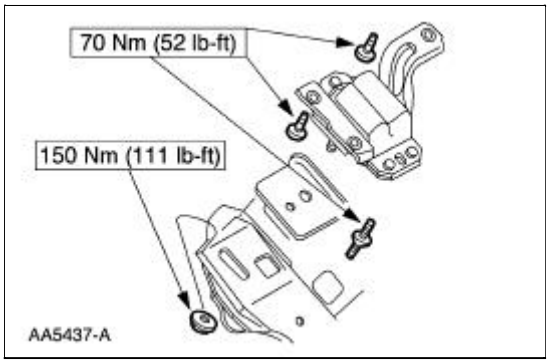


7. Raise and support the vehicle. For additional information, refer to Section 100-02 .
8. Remove the engine mount.



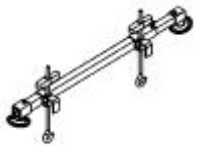
Installation

1. To install, reverse the removal procedure.


70 Nm (52 lb-ft)
150 Nm (111 lb-ft)
AA5437-A

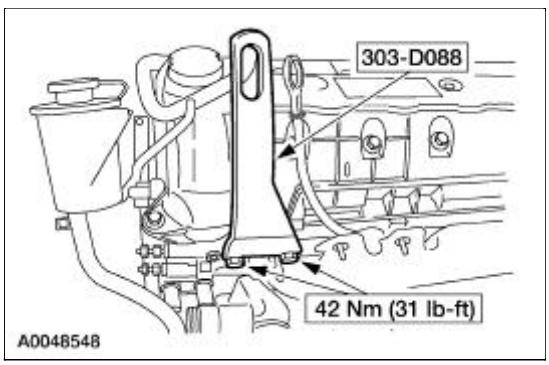
Engine Mount LH

Special Tool(s)

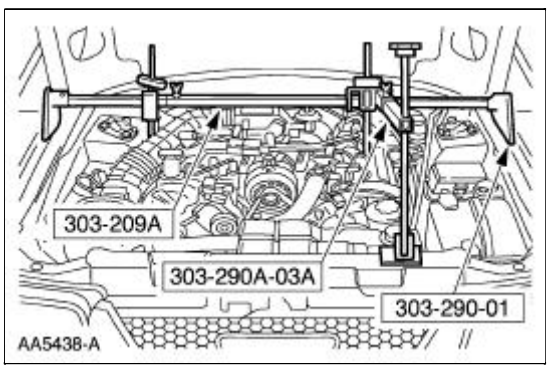
ST1603-A	Lifting Bracket, Engine 303-D088 (D93P-6001-A2)
 ST2363-A	Support Bar, Engine 303-290-A

Removal

1. Install the special tool.

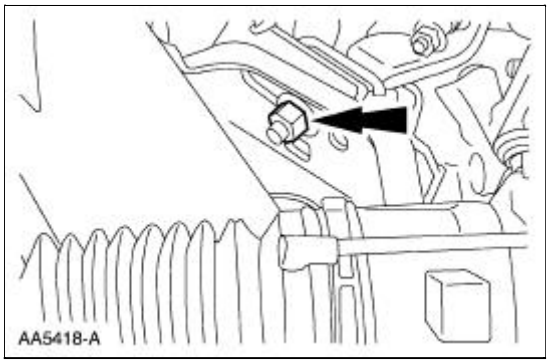


2. Install the special tools.

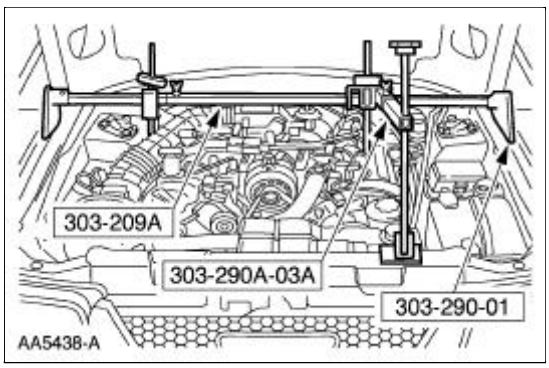


3. Raise and support the vehicle. For additional information, refer to Section 100-02 .

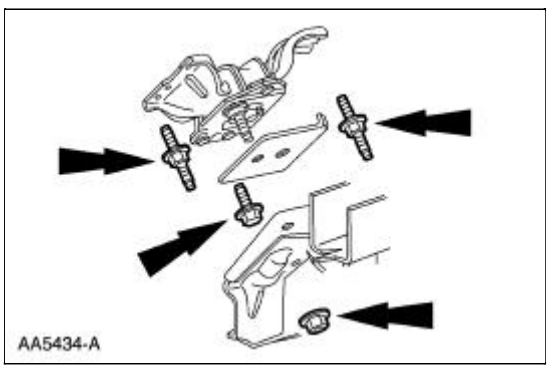
4. Remove the two engine mount nuts.



5. Lower the vehicle.
6. Using the special tools, raise the engine.

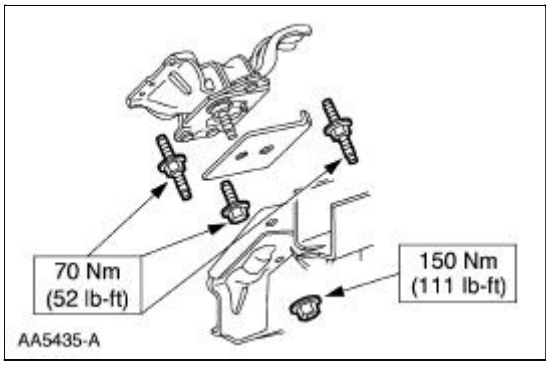


7. Raise and support the vehicle. For additional information, refer to Section 100-02 .
8. Remove the engine mount.



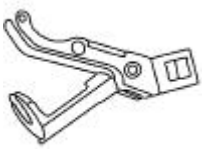
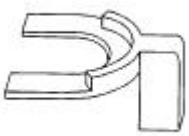
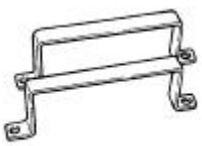
Installation

1. To install, reverse the removal procedure.


70 Nm
(52 lb-ft)
150 Nm
(111 lb-ft)
AA5435-A

Cylinder Heads

Special Tool(s)

ST1286-A	Remover, Crankshaft Vibration Damper 303-009 (T58P-6316-D)
ST1730-A	Remover, Crankshaft Front Oil Seal 303-107 (T74P-6700-A)
ST2443-A	Engine Lift Bracket Set 303-DS086 (D93P-6001-A)
 ST1693-A	Compressor, Valve Spring (Exhaust) 303-567 (T97P-6565-AH)
 ST1331-A	Compressor Spacer, Valve Spring 303-382 (T91P-6565-AH)
 ST1668-A	Remover/Installer, Cylinder Head 303-572 (T97T-6000-A)

Material

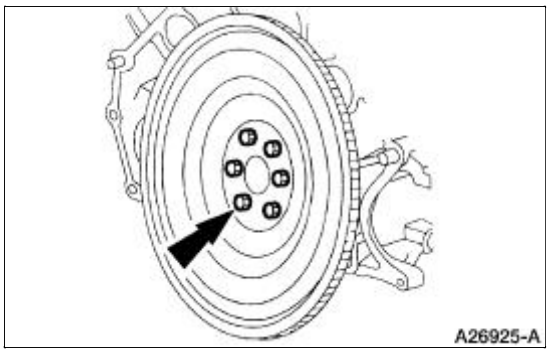
Item	Specification
Motorcraft Silicone Gasket Remover ZC-30	—
Motorcraft Metal Surface Prep	—

Removal

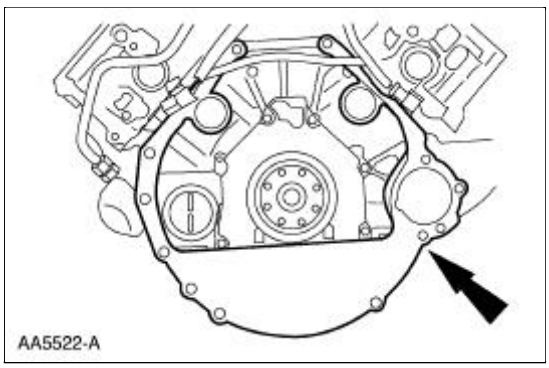
Both cylinder heads

1. Remove the engine. For additional information, refer to Engine in the Removal portion of this section.

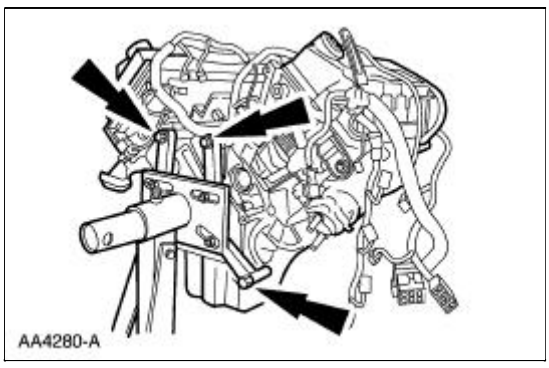
2. Remove the flywheel.



3. Remove the separator plate.

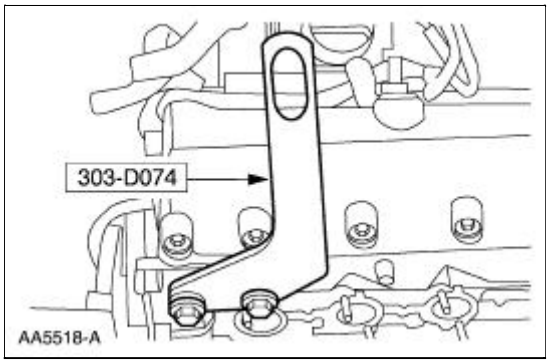


4. Mount the engine on a suitable engine stand.

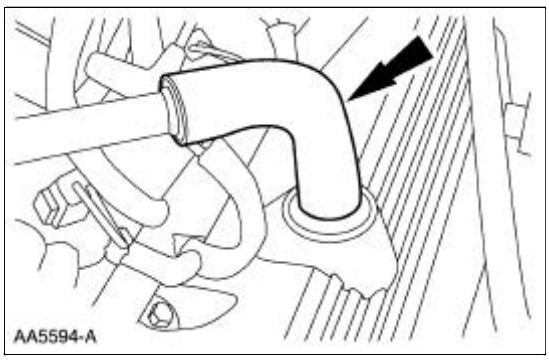


5. **NOTE:** RH shown, LH similar.

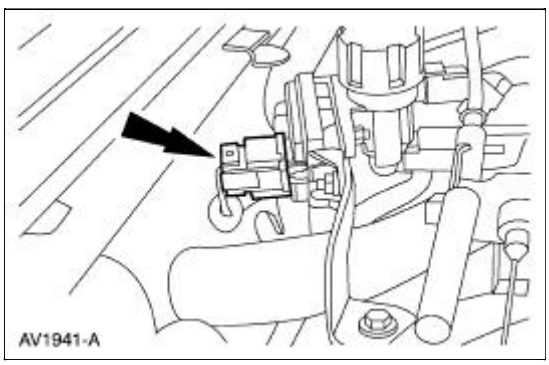
   Remove the RH and LH lifting eyes.



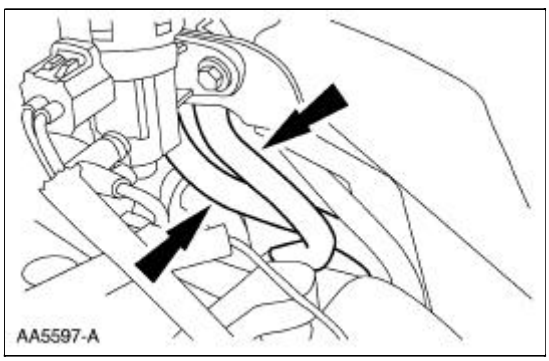
6. Remove the breather tube.



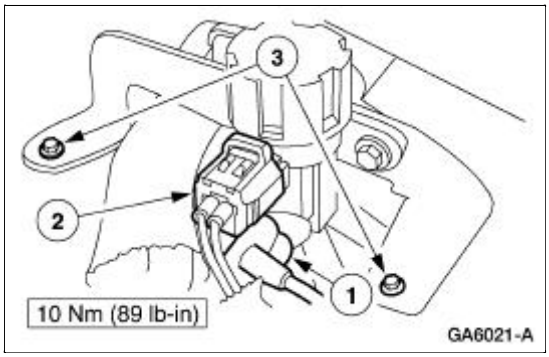
7. Disconnect the differential pressure feedback exhaust gas recirculation (EGR) electrical connector.



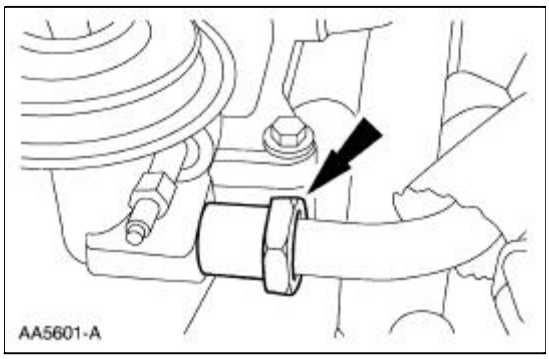
8. Disconnect the hoses from the differential pressure feedback EGR transducer.



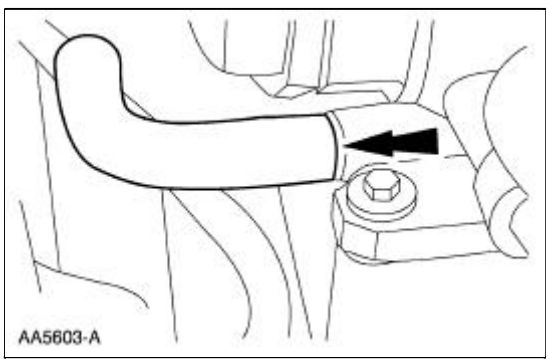
9. Remove the EGR vacuum regulator solenoid.
    1. Remove the vacuum lines.
    2. Remove the electrical connector.
    3. Remove the bolts.



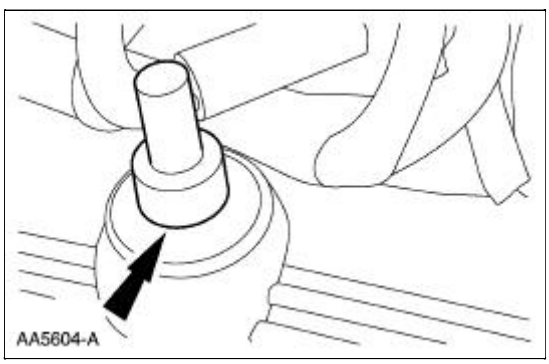
10. Disconnect the EGR tube from the EGR valve.



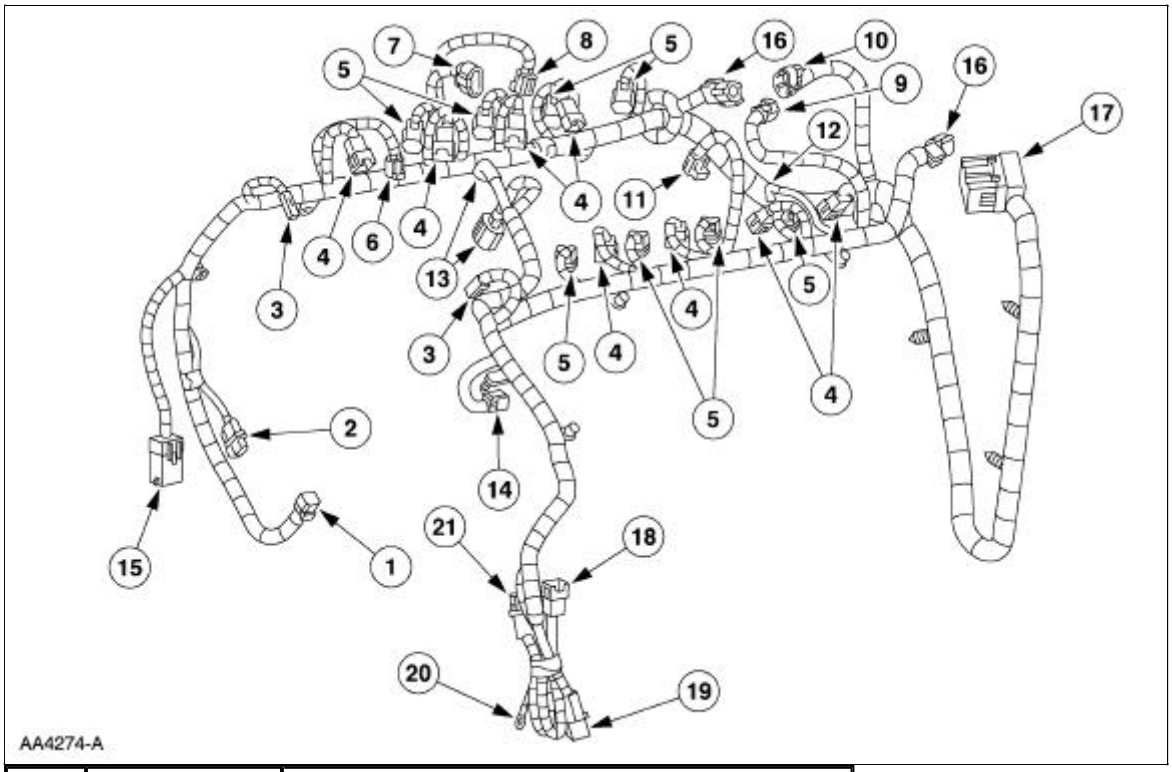
11. Disconnect the positive crankcase ventilation (PCV) hose from the base of the throttle body.



12. Remove the PCV valve and hose as an assembly.

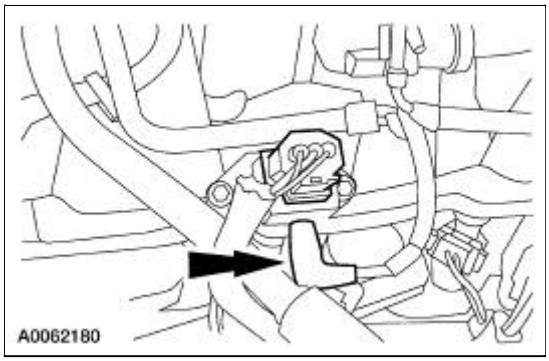


13. Remove the engine wiring harness.

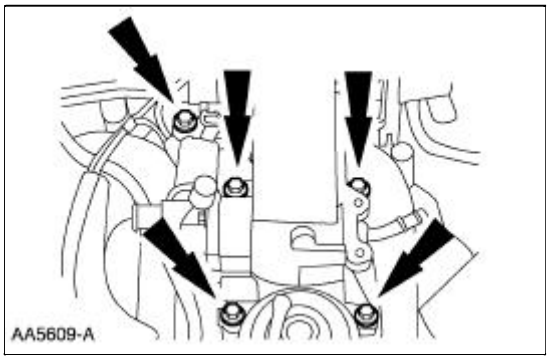


Item	Part Number	Description
1	—	To crankshaft position sensor
2	—	To A/C compressor
3	—	To radio ignition interference capacitor (2)
4	—	To fuel injectors (8)
5	—	To ignition coils (8)
6	—	To engine coolant temperature sensor
7	—	To throttle position sensor
8	—	To idle air control valve
9	—	To EGR vacuum regulator
10	—	To differential pressure feedback EGR
11	—	To fuel pressure regulator
12	—	Fuel injection ground
13	—	To generator
14	—	To camshaft position sensor
15	—	To body
16	—	To heated oxygen sensor (2)
17	—	Engine bulkhead connector
18	—	To low coolant sensor
19	—	To body
20	—	To power distribution box
21	—	To body

14. Disconnect the vacuum line from the fuel pressure sensor.



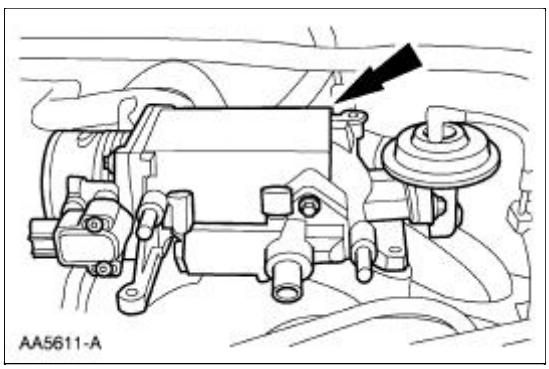
15. Remove the throttle body bolts.



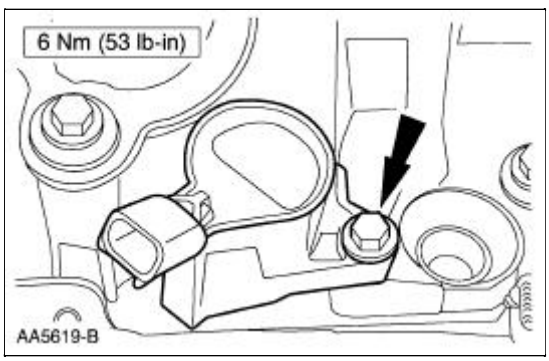
16. **NOTE:** The gasket is reusable if not damaged.

    Remove the throttle body and adapter as an assembly.

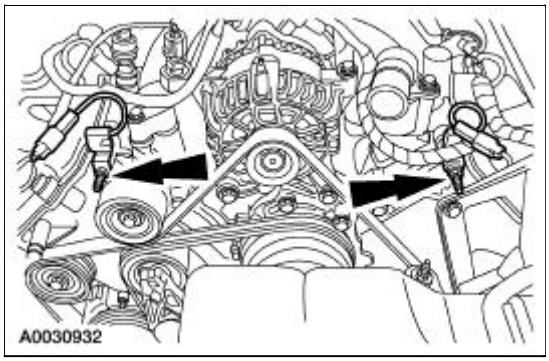
    - Inspect and clean the sealing surfaces.



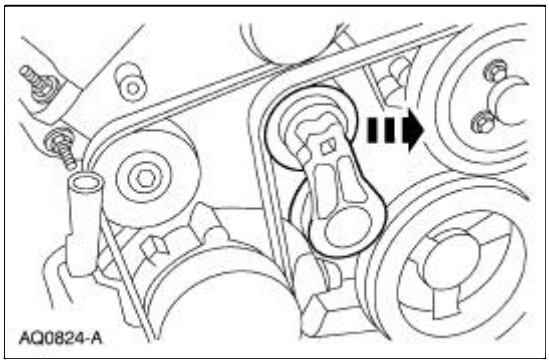
17. Remove the ignition coils.



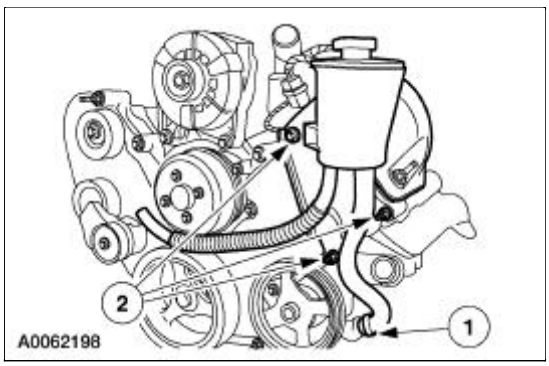
18. Remove the radio interference capacitors.



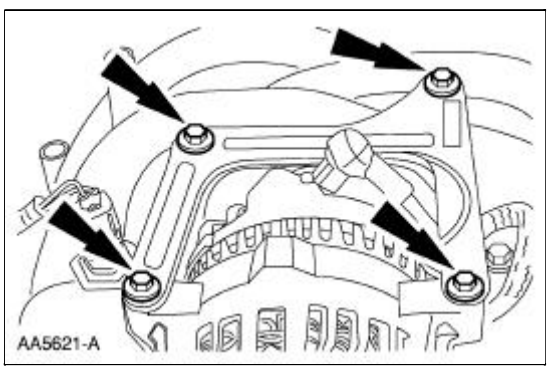
19. Remove the accessory drive belt.



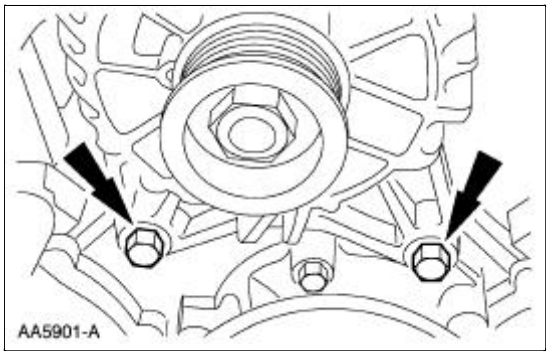
20. Remove the power steering reservoir and bracket as an assembly.
    1. Disconnect the supply line from the pump.
    2. Remove the (3) bolts and the reservoir and bracket.



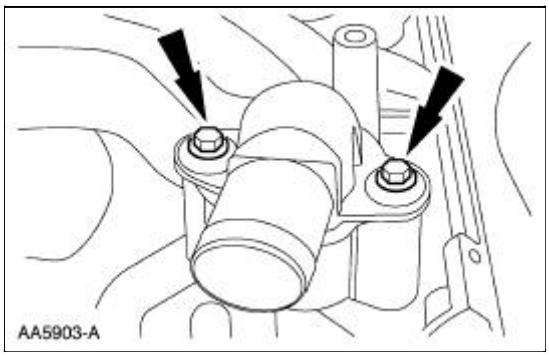
21. Remove the upper generator support bracket.



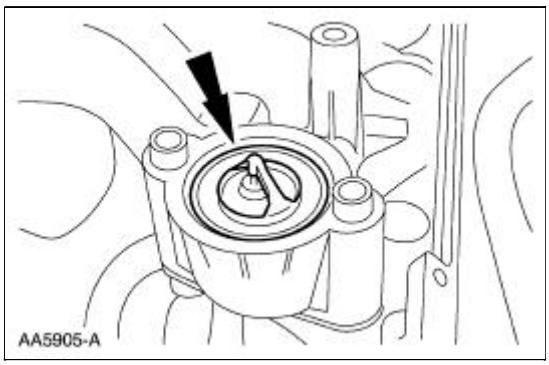
22. Remove the bolts and the generator.



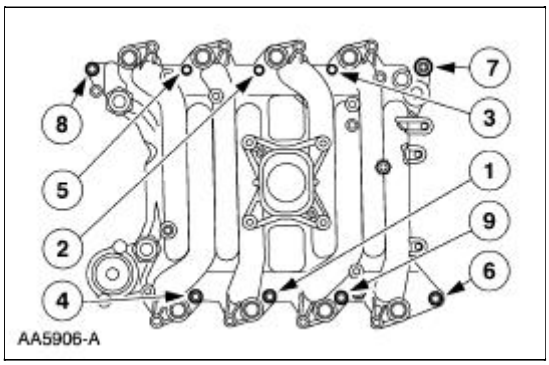
23. Remove the coolant outlet adapter.



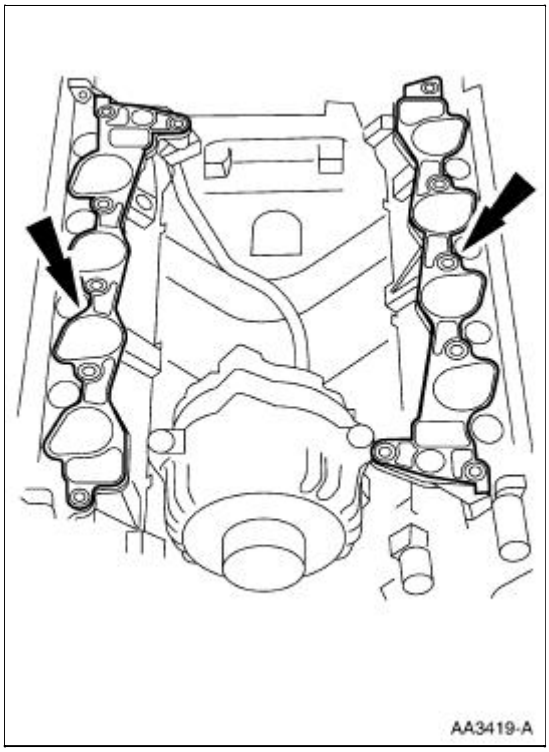
24. Remove the thermostat and O-ring.



25. Remove the bolts in the sequence shown, and remove the intake manifold.



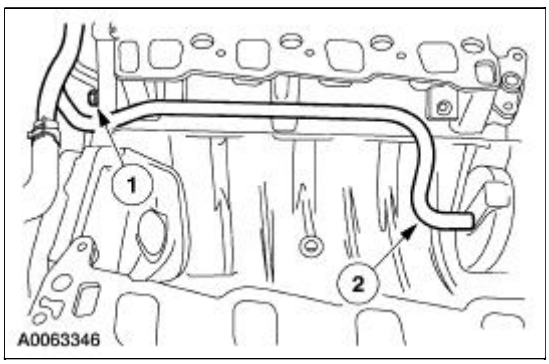
26. Remove the intake manifold gaskets.



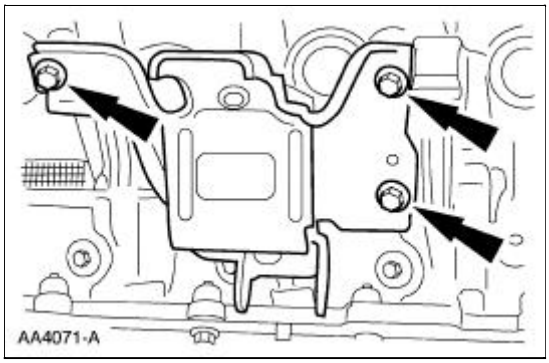
27. **CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean sealing surfaces. These tools will cause scratches and gouges which make leak paths.**

    Clean the sealing surfaces.

28. Remove the coolant bypass tube.
    1. Remove the nut.
    2. Remove the coolant bypass tube.



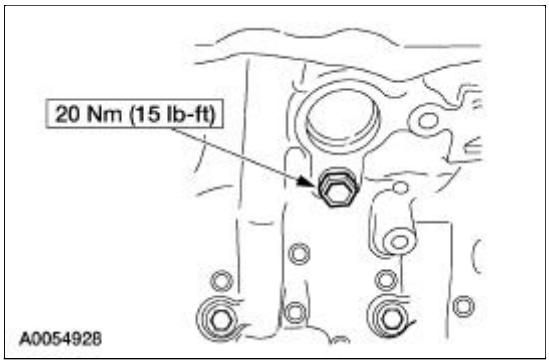
29. Remove the RH engine mount.



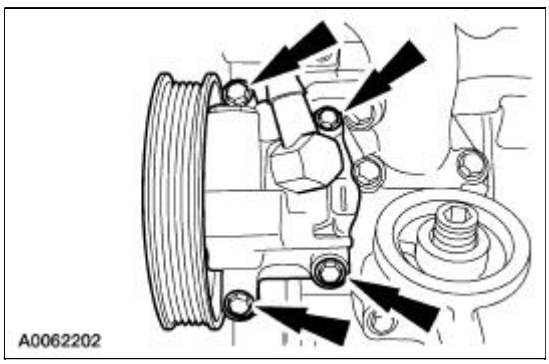
30. **NOTE:** LH shown; RH similar.

    Using a suitable container, drain coolant from the engine block.

    - Install the drain plugs when finished.

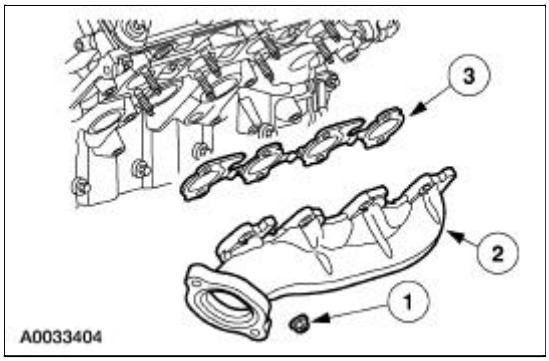


31. Remove the four bolts and the power steering pump.



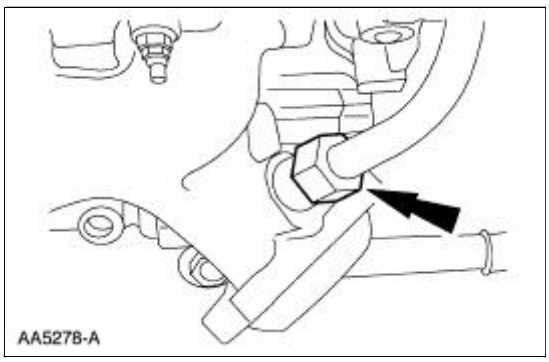
RH cylinder head

32. Remove the RH exhaust manifold.
    1. Remove the RH exhaust manifold nuts.
    2. Remove the RH exhaust manifold.
    3. Remove the RH exhaust manifold gasket and discard.

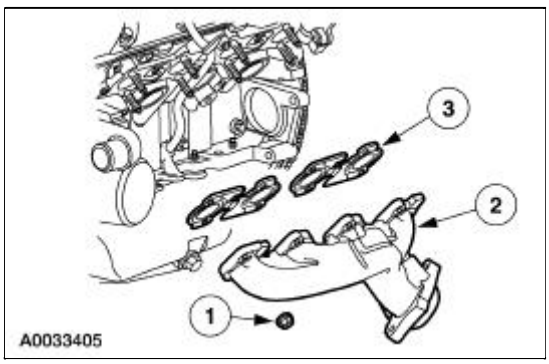


LH cylinder head

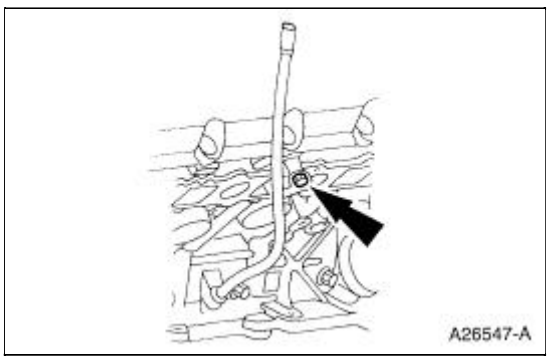
33. Disconnect the EGR tube at the exhaust manifold.



34. Remove the LH exhaust manifold.
    1. Remove the LH exhaust manifold nuts.
    2. Remove the LH exhaust manifold.
    3. Remove the LH exhaust manifold gasket and discard.



35. Remove the oil level indicator tube bolt.



36. Remove the oil level indicator tube.

Both cylinder heads

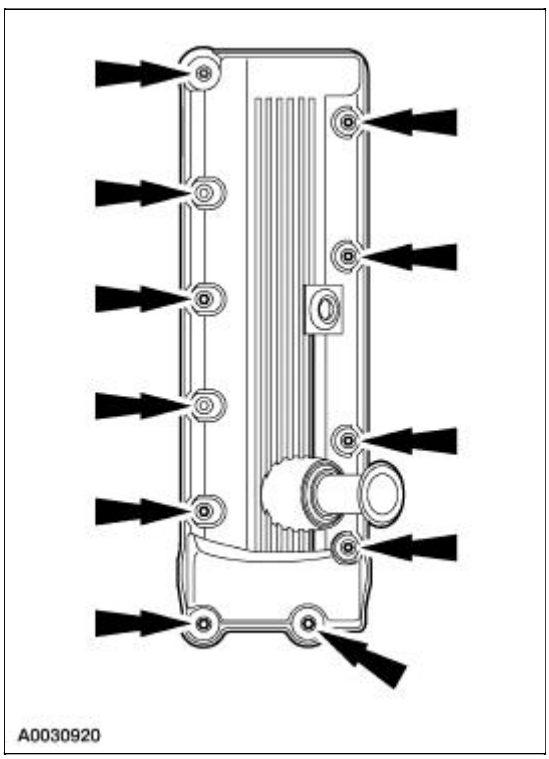
37. Clean and inspect the exhaust manifolds. For additional information, refer to Section 303-00 .

38. **CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.**

    NOTE: The bolts are part of the valve cover and should not be removed. RH valve cover shown, LH valve cover similar.

    Remove the RH and LH valve covers.

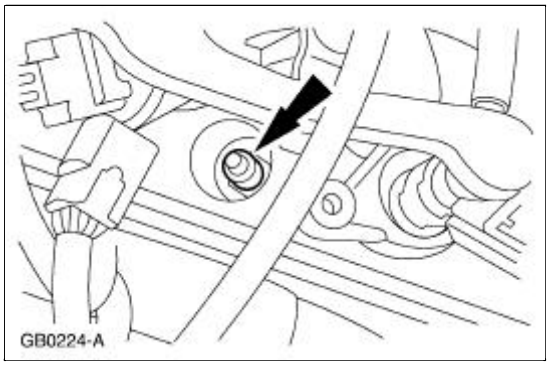
    - Fully loosen the bolts and remove the valve covers.
    - Clean the valve cover mating surface of the cylinder heads with silicone gasket remover and metal surface prep. Follow the directions on the packaging.
    - Inspect the valve cover gasket(s). If the gasket(s) is damaged, remove and discard the gasket(s). Clean the valve cover gasket groove(s) with soap and water or a suitable solvent.



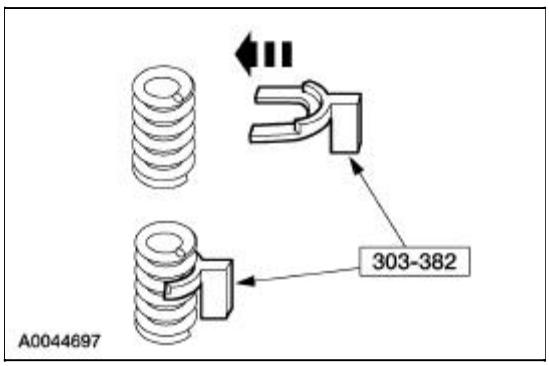
39. **NOTE:** Use compressed air to remove any foreign material from the spark plug well before removing the spark plugs.

    NOTE: One spark plug shown, others are similar.

    Remove the spark plugs.

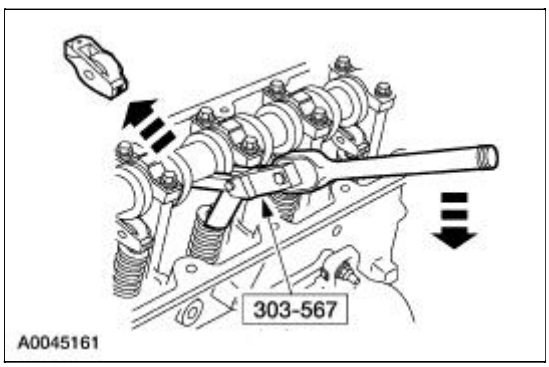


40. Install the special tool between the valve spring coils to prevent valve stem seal damage.

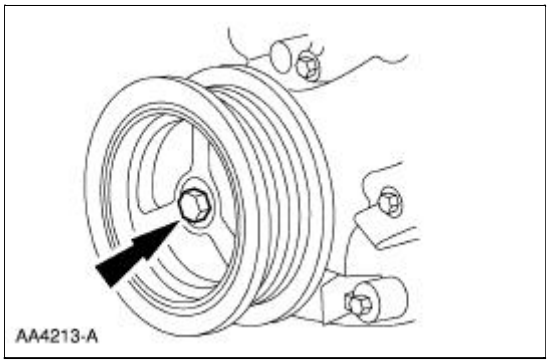


41. **NOTE:** Rotate the camshaft to see the base circle of the camshaft's lobe before removing the followers. Keep roller followers in order when removing.

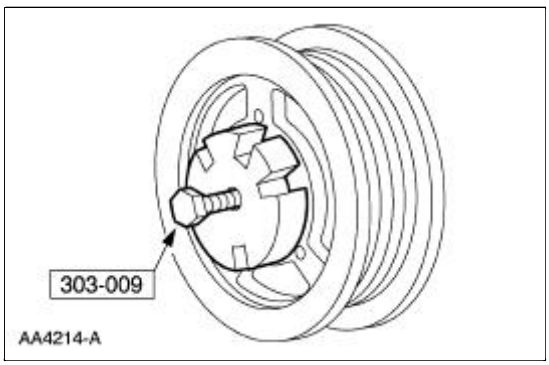
    Use the special tool to compress the valve springs and remove the 16 camshaft roller followers. Rotate the camshaft and crankshaft as necessary.



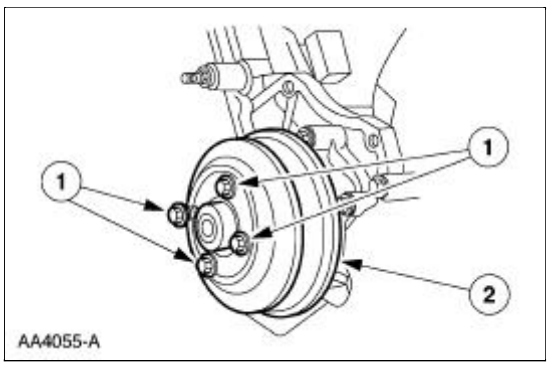
42. Remove the crankshaft pulley bolt.



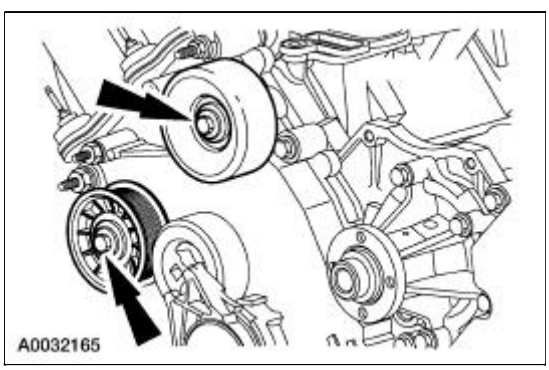
43. Using the special tool, remove the crankshaft pulley.



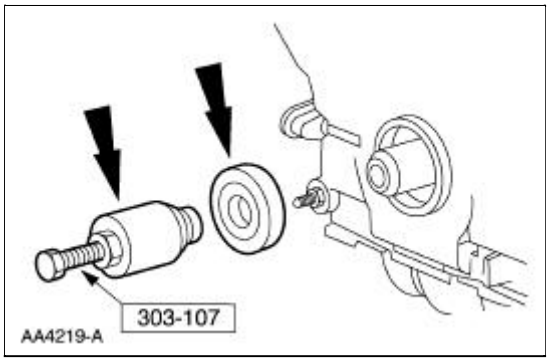
44. Remove the coolant pump pulley.
    1. Remove the coolant pump pulley bolts.
    2. Remove the coolant pump pulley.



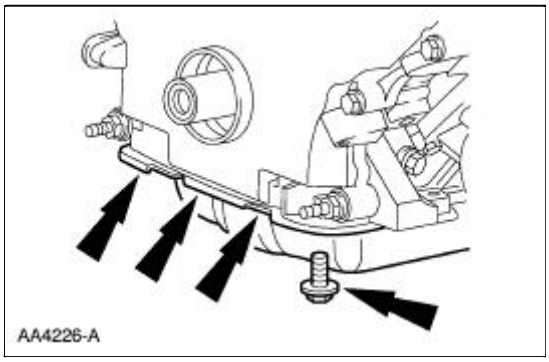
45. Remove the bolts and belt idler pulleys.



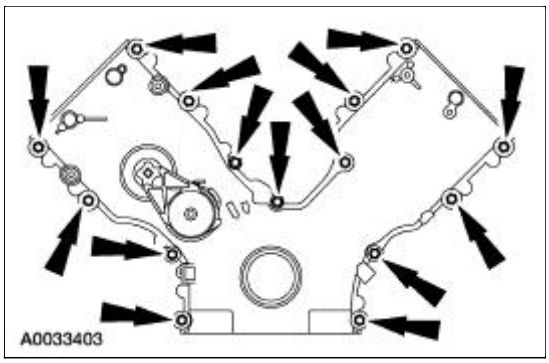
46. Using the special tool, remove the engine front cover seal.



47. Remove the bolts.

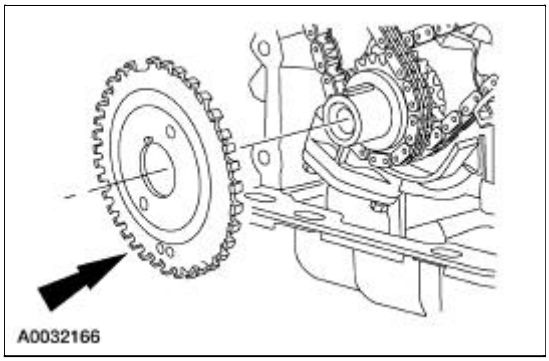


48. Remove the bolts, the studs, and the engine front cover.
    - Discard the gaskets, clean and inspect the sealing surfaces.

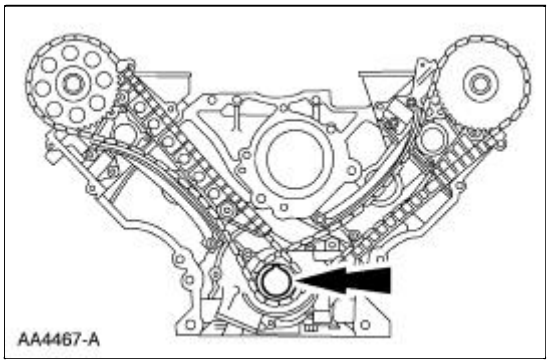


CAUTION: Since the engine is not free-wheeling, if the crankshaft or the camshafts are moved in any manner during removal and installation, the crankshaft and the camshafts must be re-synchronized.

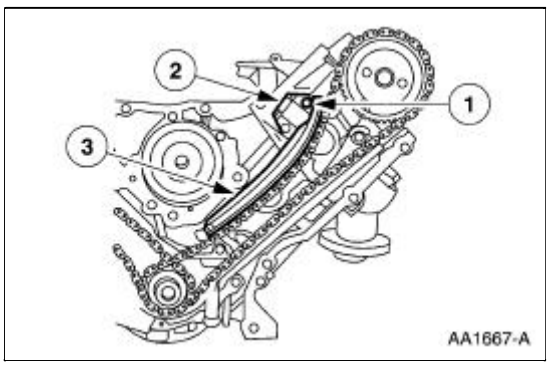
49. Remove the crankshaft sensor ring from the crankshaft.



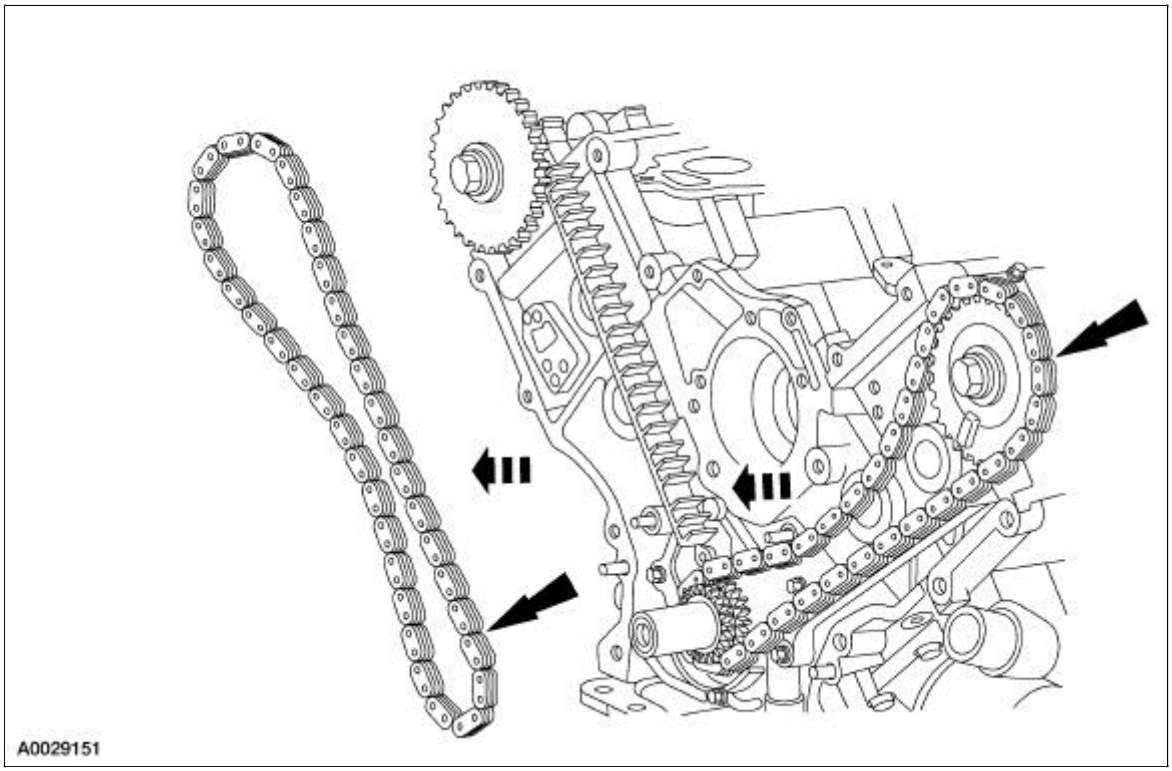
50. Position the crankshaft with the keyway at the 12 o'clock position.



51. Remove the RH and LH timing chain tensioning system from both timing chains.
    1. Remove the bolts.
    2. Remove the timing chain tensioners.
    3. Remove the timing chain tensioner arms.

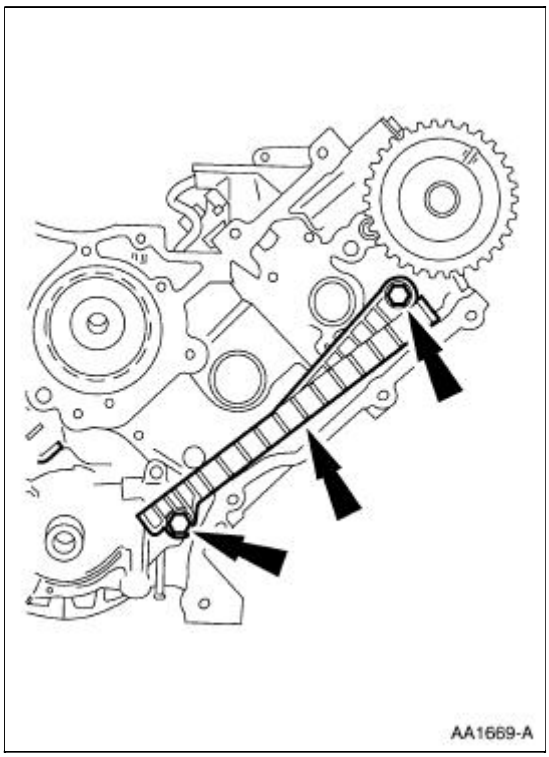


52. Remove the LH and RH timing chains and the crankshaft sprocket.
    - Remove the RH timing chain from camshaft sprocket.
    - Remove the RH timing chain from the crankshaft sprocket.
    - Remove the LH timing chain from the camshaft sprocket.
    - Remove the LH timing chain and crankshaft sprocket.



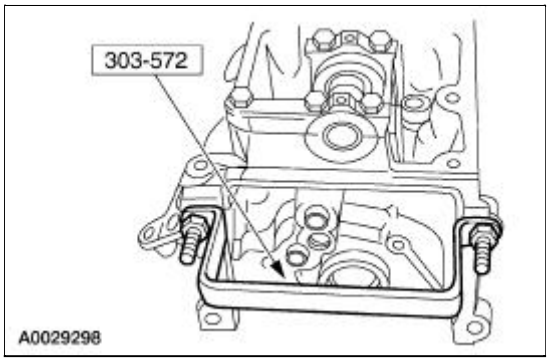
53. **NOTE:** LH shown; RH similar.

    Remove the bolts and the timing chain guides.



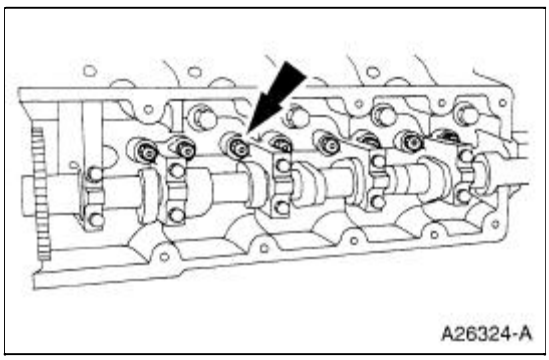
54. **NOTE:** LH shown; RH similar.

    Install the lifting handles to the RH and LH cylinder heads.



55. **NOTE:** The hydraulic lash adjusters must be reinstalled in their original locations. Record the hydraulic lash adjuster locations.

    Remove the hydraulic lash adjusters.



RH cylinder head

56. **CAUTION: The cylinder head must be cool before removing it from the engine. Cylinder head warpage can result if a warm or hot cylinder head is removed.**

    CAUTION: Place clean shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine.

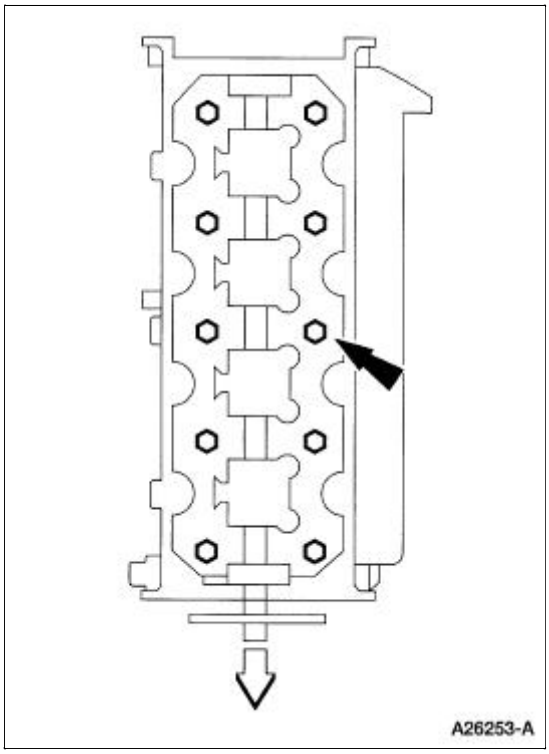
    CAUTION: The cylinder head bolts must be discarded and new bolts installed. They are tighten-to-yield designed and cannot be reused.

    CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges that make leak paths. Use a plastic scraping tool to remove all traces of the head gasket.

    CAUTION: Aluminum surfaces are soft and can be scratched easily. Never place the cylinder head gasket surface, unprotected, on a bench surface.

    Remove the bolts and the RH cylinder head.

    - Discard the cylinder head gasket.
    - Discard the cylinder head bolts.



LH cylinder head

57. **CAUTION: The cylinder head must be cool before removing it from the engine. Cylinder head warpage can result if a warm or hot cylinder head is removed.**

CAUTION: Place clean shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine.

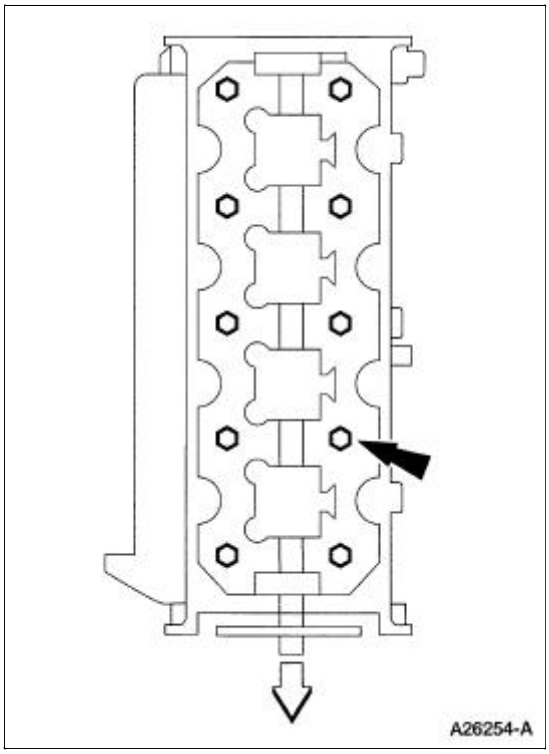
CAUTION: The cylinder head bolts must be discarded and new bolts installed. They are tighten-to-yield designed and cannot be reused.

CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges that make leak paths. Use a plastic scraping tool to remove all traces of the head gasket.

CAUTION: Aluminum surfaces are soft and can be scratched easily. Never place the cylinder head gasket surface, unprotected, on a bench surface.

Remove the bolts and the LH cylinder head.

- Discard the cylinder head gasket.
- Discard the cylinder head bolts.



Both cylinder heads

58. **CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges that make leak paths. Use a plastic scraping tool to remove all traces of the head gasket.**

    CAUTION: Observe all warnings or cautions and follow all application directions contained on the packaging of the silicone gasket remover and the metal surface prep.

    NOTE: If there is no residual gasket material present, metal surface prep can be used to clean and prepare the surfaces.

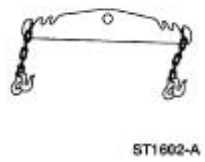
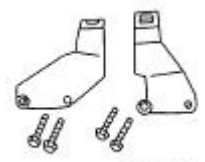
    Clean the cylinder head-to-cylinder block mating surfaces of both the cylinder head and the cylinder block.
    1. Remove any large deposits of silicone or gasket material with a plastic scraper.
    2. Apply silicone gasket remover, following package directions, and allow to set for several minutes.
    3. Remove the silicone gasket remover with a plastic scraper. A second application of silicone gasket remover may be required if residual traces of silicone or gasket material remain.
    4. Apply metal surface prep, following package directions, to remove any remaining traces of oil or coolant, and to prepare the surfaces to bond with the new gasket. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

59. **NOTE:** The straightedge used must be flat within 0.0051 mm (0.0002 in) per foot of tool length.

    Support the cylinder head on a bench with the head gasket side up. Inspect all areas of the deck face with a straightedge, paying particular attention to the oil pressure feed area. The cylinder head must not have depressions deeper than 0.0254 mm (0.001 in) across a 38.1 mm (1.5 in) square area, or scratches more than 0.0254 mm (0.001 in) .

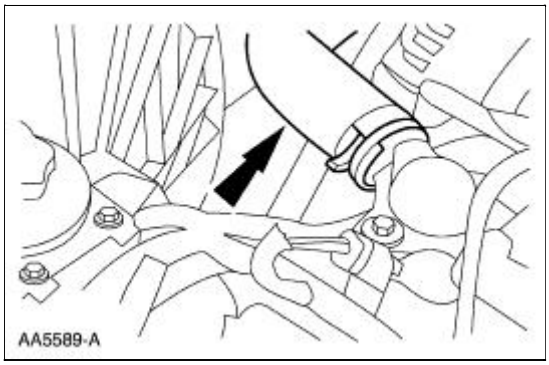
Engine

Special Tool(s)

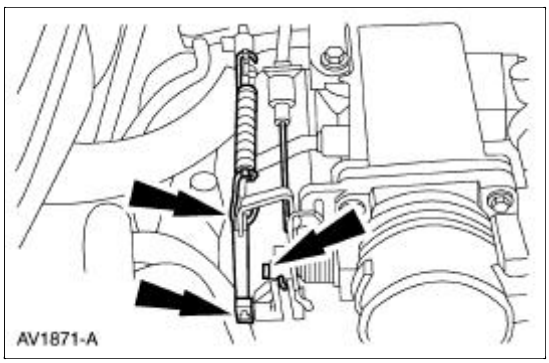
ST2334-A	Support Bracket, Engine 303-639
 ST1602-A	Spreader Bar 303-D089 (D93P-6001-A3)
 ST1701-A	Lifting Bracket Set, Engine 303-D074 (D91P-6001-A)

Removal

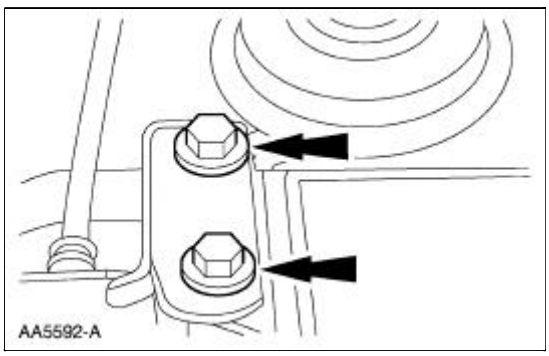
1. Remove the hood.
2. Remove the battery. For additional information, refer to Section 414-01 .
3. Remove the air cleaner and outlet tube. For additional information, refer to Section 303-12 .
4. Drain the engine cooling system. For additional information, refer to Section 303-03A or Section 303-03B .
5. Remove the degas bottle. For additional information, refer to Section 303-03A or Section 303-03B .
6. Recover the A/C system. For additional information, refer to Section 412-00 .
7. Disconnect the fuel lines. For additional information, refer to Section 310-00 .
8. Disconnect the upper radiator hose from the water outlet connector.



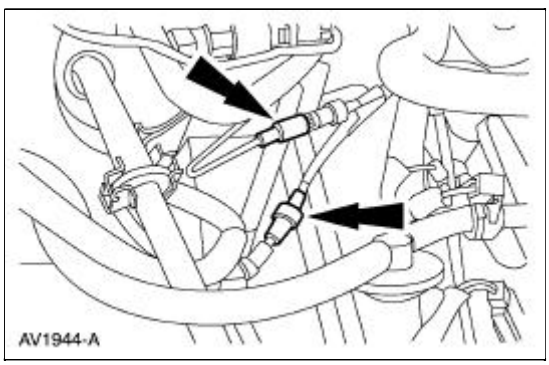
9. Disconnect the throttle cable, speed control actuator cable and the return spring.



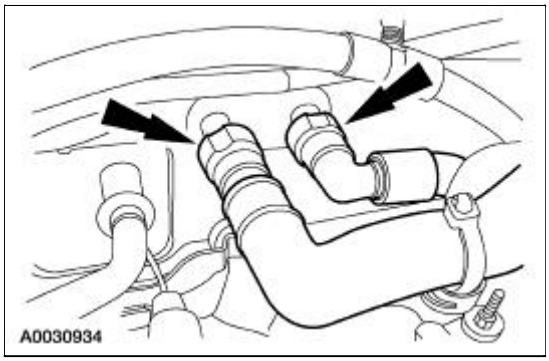
10. Remove the bolts and position the cables and bracket out of the way.



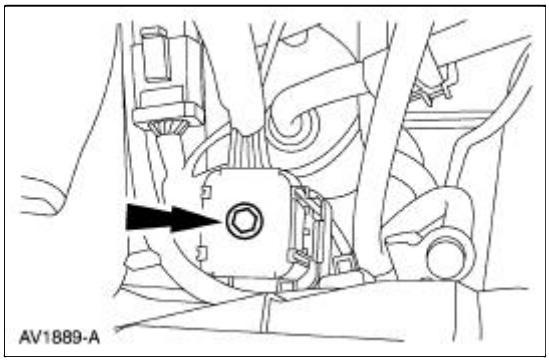
11. Disconnect the climate control vacuum supply hoses.



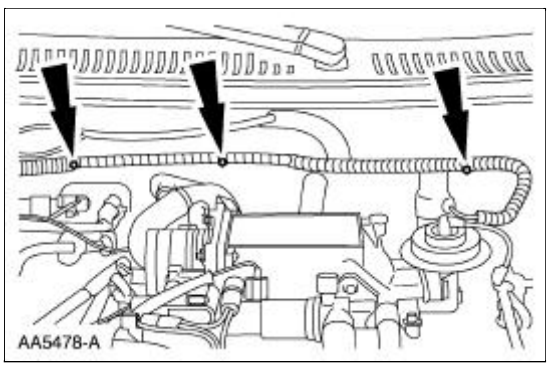
12. Disconnect the two heater water hoses.



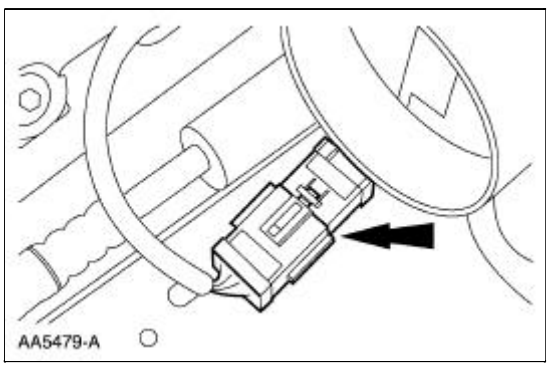
13. Disconnect the engine bulkhead connector.



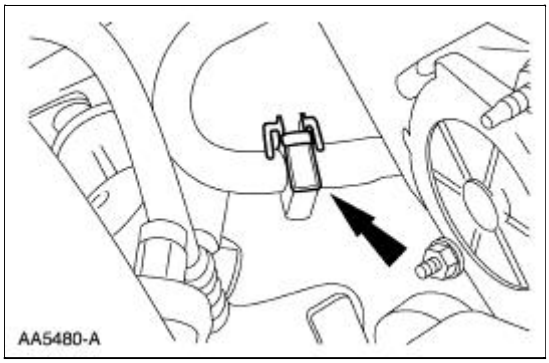
14. Separate the harness in three locations.



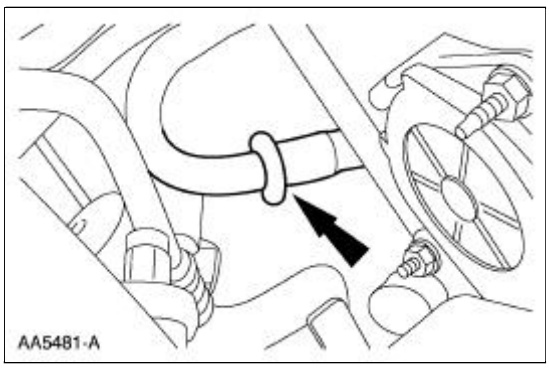
15. Disconnect the electrical connector.



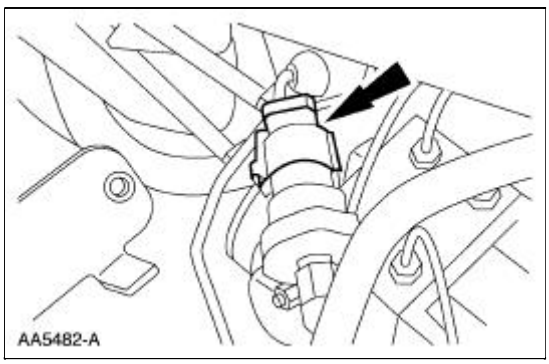
16. Remove the safety clip from the manifold suction tube.



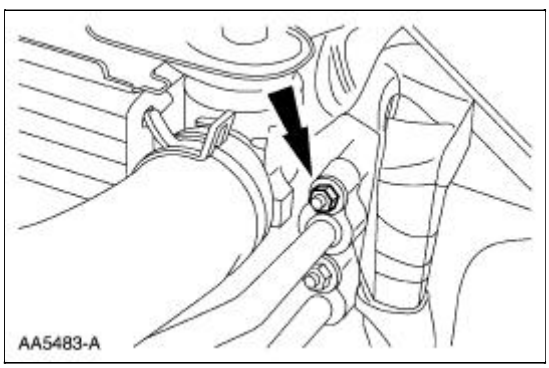
17. Disconnect the A/C manifold suction tube.



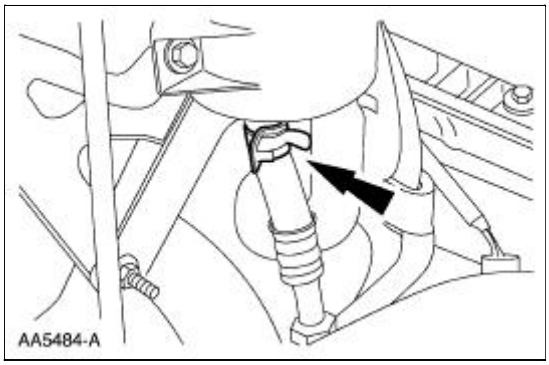
18. Disconnect the A/C pressure cycle switch.



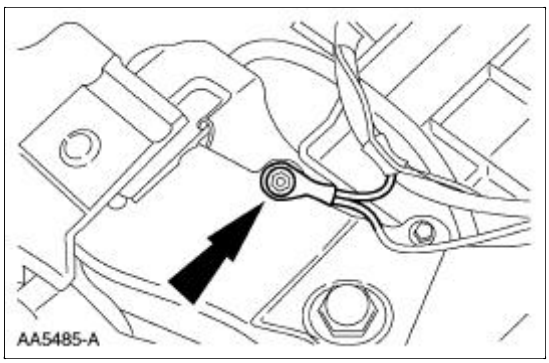
19. Remove the nut and separate the liquid tube from the A/C condenser.



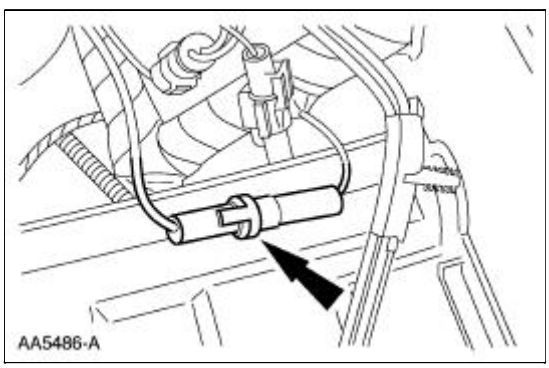
20. Disconnect the power steering hose from the reservoir.



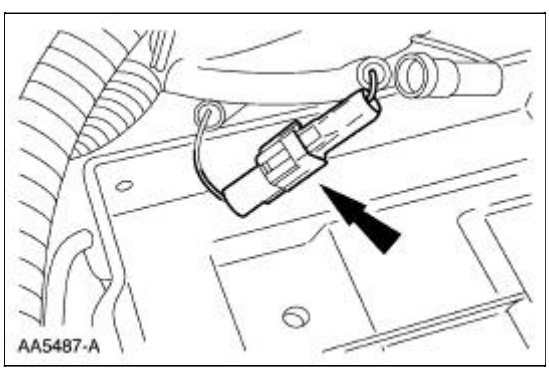
21. Remove the bolt and the body ground.



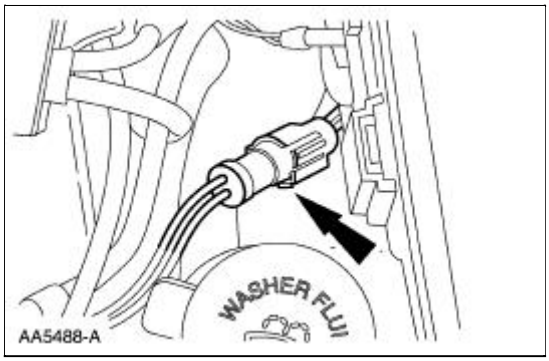
22. Separate the fuse link.



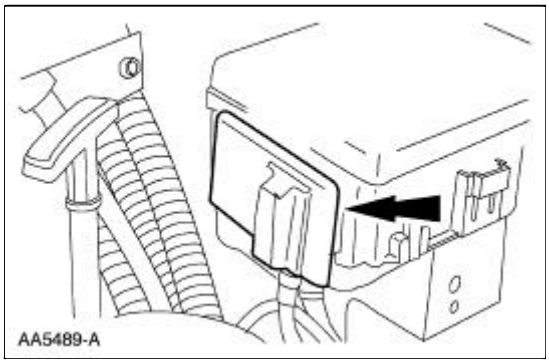
23. Disconnect the connector.



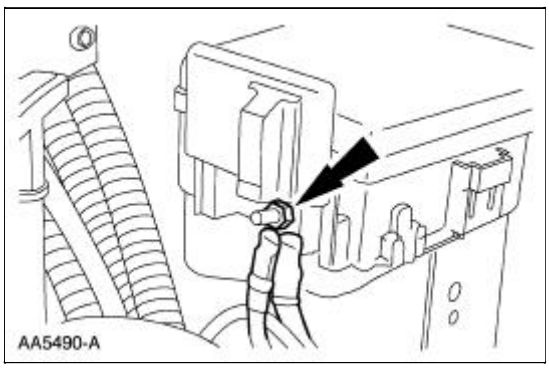
24. Disconnect the ground connector.



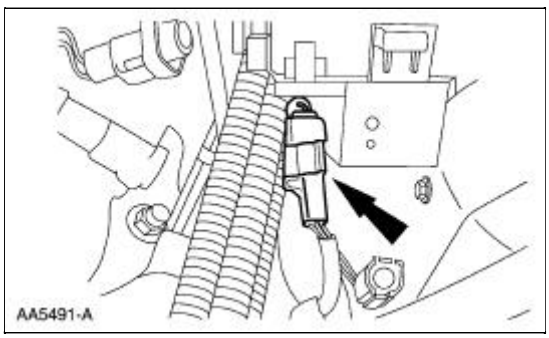
25. Slide the access cover up.



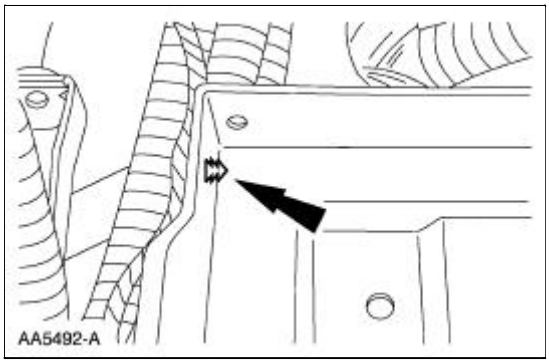
26. Remove the nut and the battery leads.



27. Disconnect the connector.

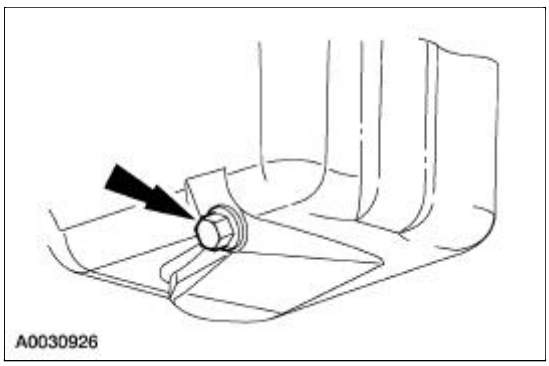


28. Separate the degas sensor lead from the battery tray.

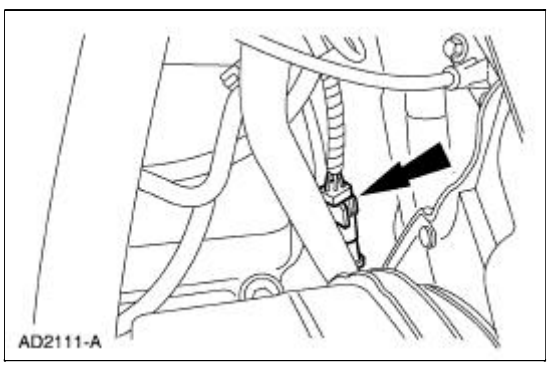


29. Raise and support the vehicle. For additional information, refer to Section 100-02 .

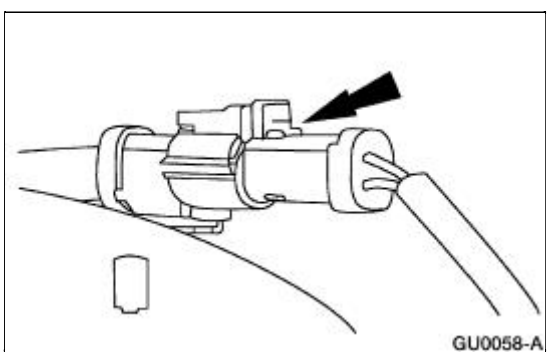
30. Drain the engine oil.



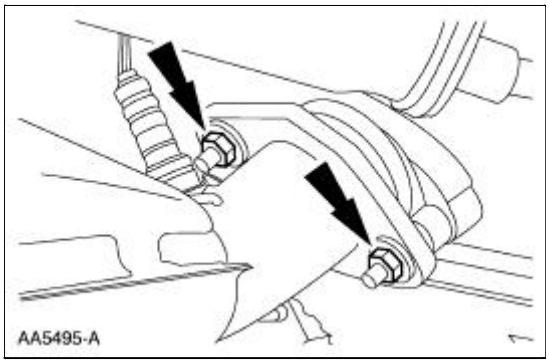
31. Disconnect the RH heated oxygen sensor connector.



32. Disconnect the LH heated oxygen sensor connector.

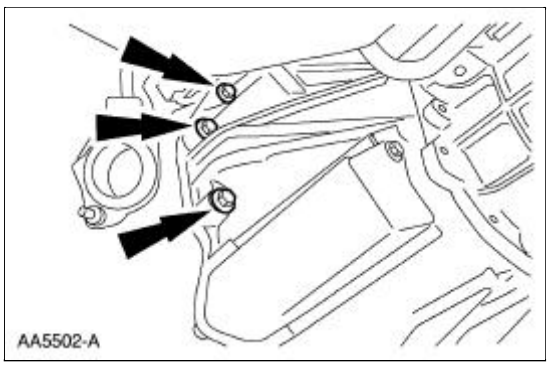


33. Remove the four exhaust manifold flange nuts.

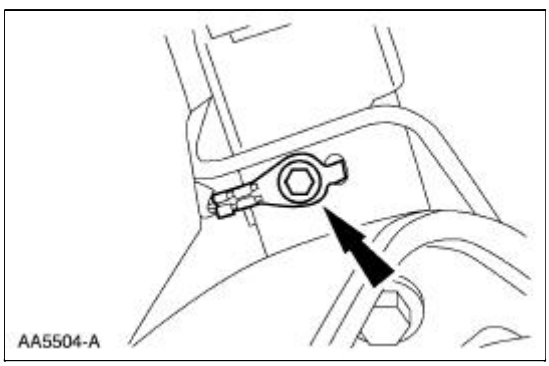


34. Remove the starter. For additional information, refer to Section 303-06 .

35. Remove the nine bell housing bolts.



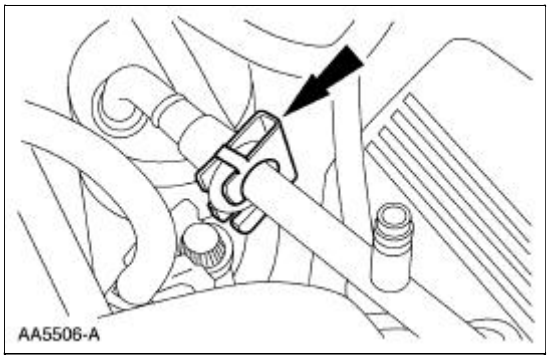
36. Remove the bolt and the body ground.



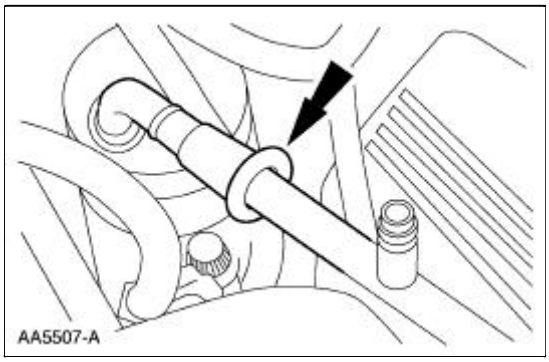
37. Remove the power steering pump. For additional information, refer to Section 211-02 .

38. Lower the vehicle.

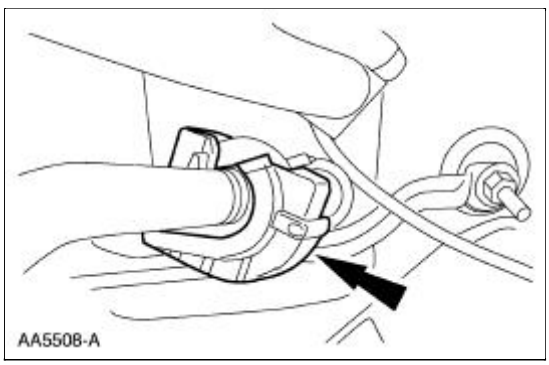
39. Remove the safety clip from the suction tube.



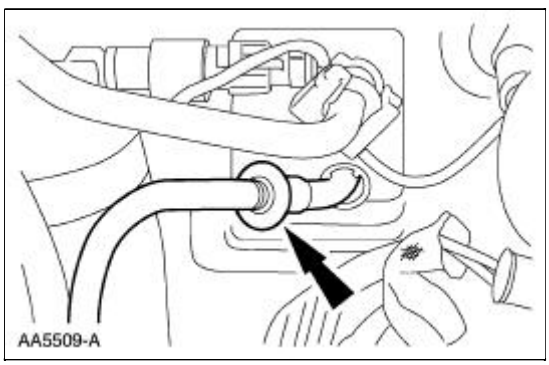
40. Disconnect the suction tube at the receiver/drier and remove the tube.



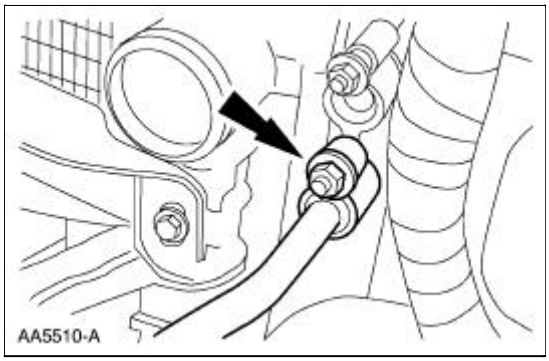
41. Remove the safety clip from the line at the evaporator core.



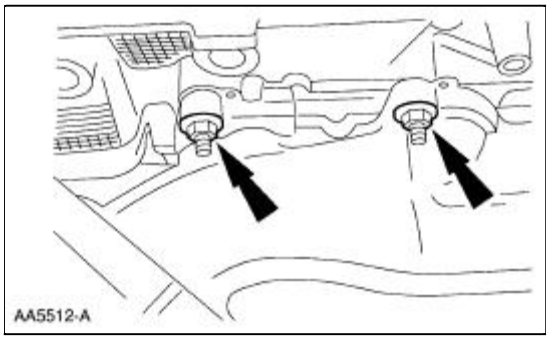
42. Disconnect the tube from the evaporator core.



43. Remove the nut and remove the tube from the vehicle.



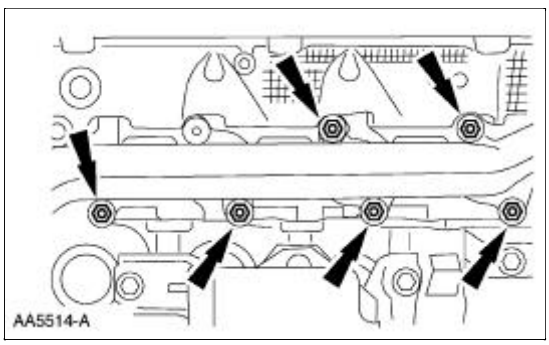
44. Remove the two nuts from the RH exhaust manifold.



45. Raise and support the vehicle. For additional information, refer to Section 100-02 .

46. **NOTE:** The manifold will not be removed from the vehicle in this step.

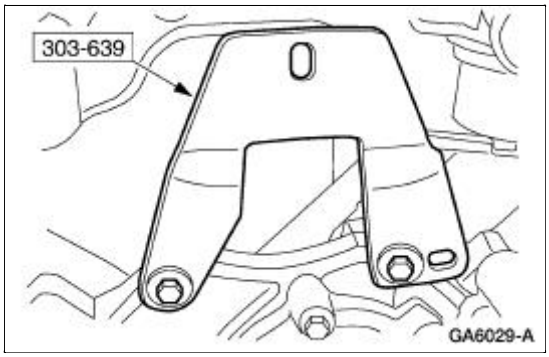
    Remove the six exhaust manifold nuts.



47. Lower the vehicle.

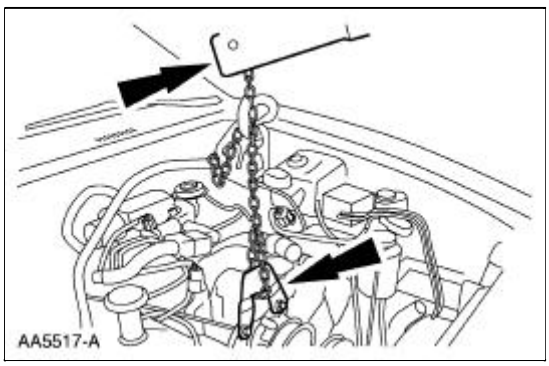
48. Remove the generator. For additional information, refer to Section 414-02 .

49. Install the special tool.

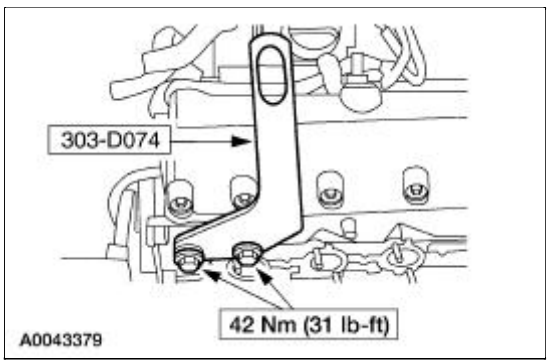


50. **NOTE:** This step will allow removal of the exhaust manifold through the bottom and access for the installation of the engine lift brackets.

    Using a suitable floor crane, raise the engine to remove the exhaust manifold.

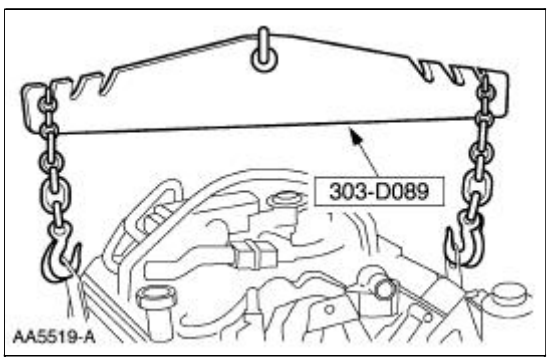


51. Install the RH and LH special tool.

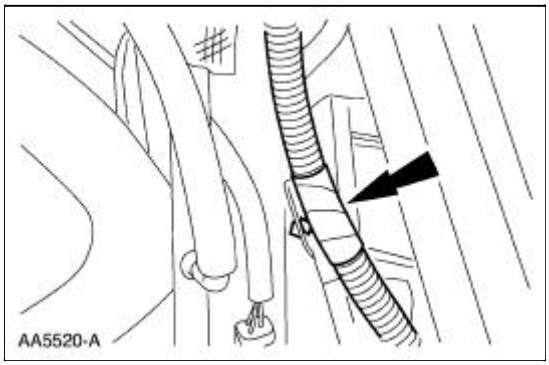


52. **NOTE:** Before carrying out this step it will be necessary to support the transmission with a floor jack and a block of wood.

    Install the special tool.

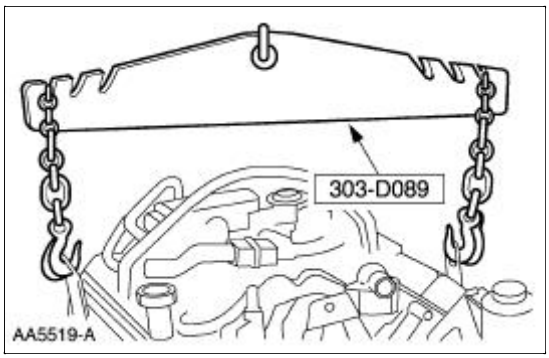


53. Separate the harness from the bracket.
    - Raise the engine slightly to gain access to the transmission wiring support bracket.



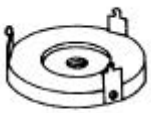
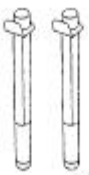
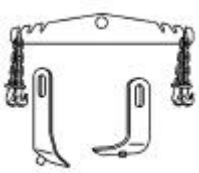
54. **NOTE:** Adjust the transmission support jack as necessary to aid in the removal of the engine.

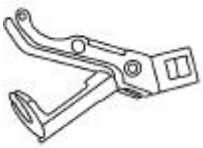
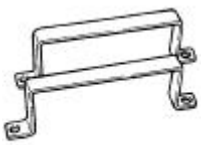
    Using the special tool, remove the engine from the vehicle.



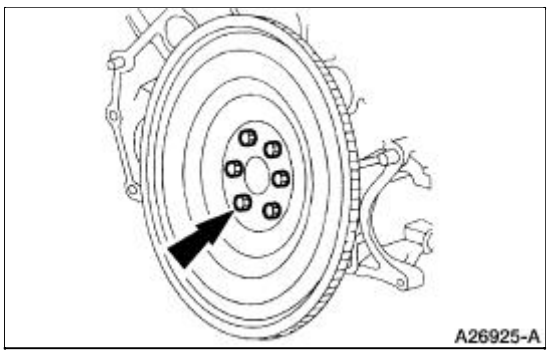
Engine

Special Tool(s)

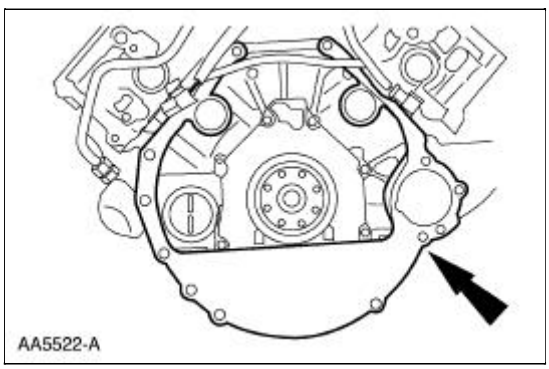
ST1185-A	Impact Slide Hammer 100-001 (T50T-100-A)
 ST1481-A	Remover, Crankshaft Rear Oil Slinger 303-514 (T95P-6701-AH)
ST1382-A	Remover, Crankshaft Rear Oil Seal 303-519 (T95P-6701-EH)
ST1286-A	Remover, Crankshaft Vibration Damper 303-009 (T58P-6316-D)
 ST1337-A	Installer, Connecting Rod 303-442 (T93P-6136-A)
ST1730-A	Remover, Crankshaft Front Oil Seal 303-107 (T74P-6700-A)
 ST2443-A	Engine Lift Bracket Set 303-DS086- (D93P-6001-EA)
	Cylinder Ridge Reamer 303-016 (T64L-6011-EA)

ST1276-A	
 ST1693-A	Compressor, Valve Spring (Exhaust) 303-567 (T97L-6565-AH)
 ST1668-A	Remover/Installer, Cylinder Head 303-572 (T97T-6000-A)

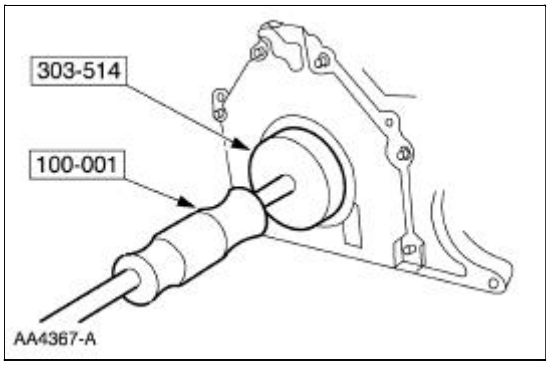
1. Remove the flywheel.



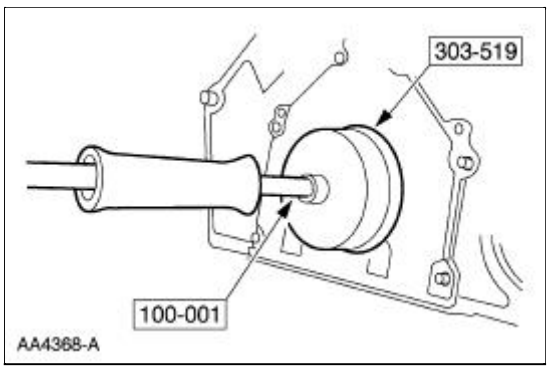
2. Remove the separator plate.



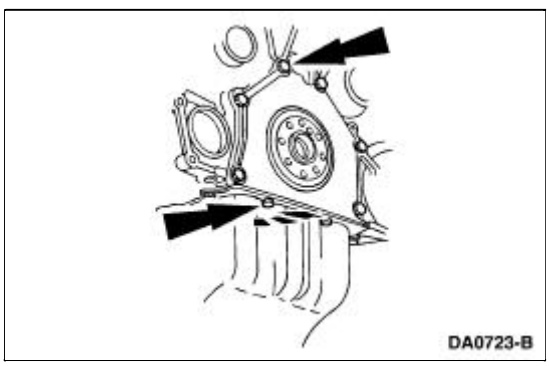
3. Using the special tools, remove the crankshaft rear oil slinger.



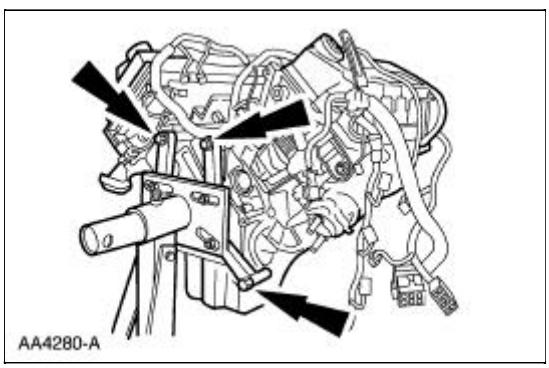
4. Using the special tools, remove the rear main seal.



5. Remove the rear seal retainer plate.

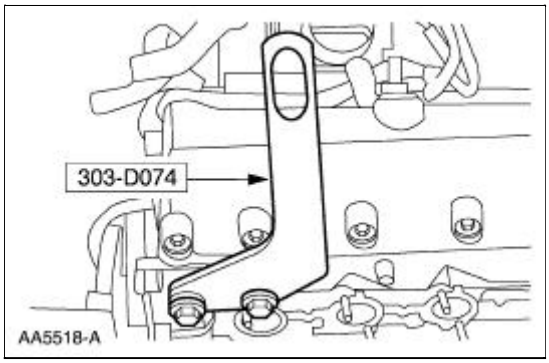


6. Mount the engine on a work stand.

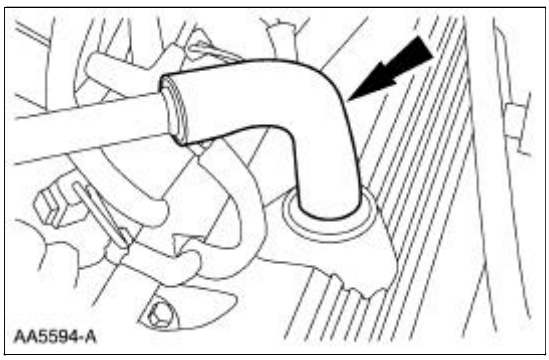


7. **NOTE:** RH shown, LH similar.

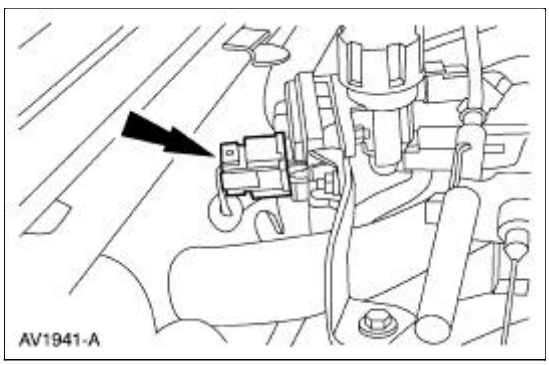
   Remove the RH and LH lifting eyes.



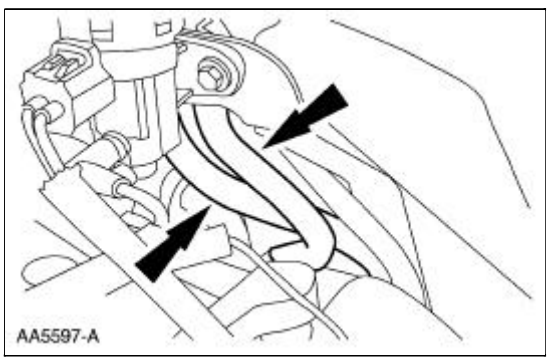
8. Remove the breather tube.



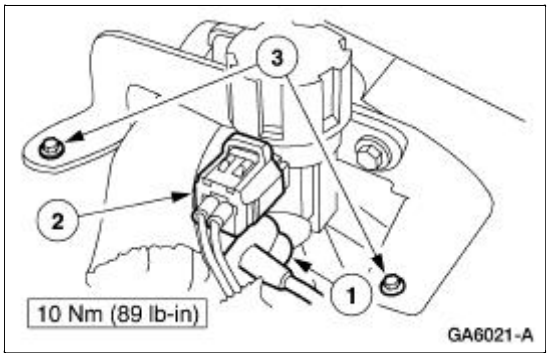
9. Disconnect the differential pressure feedback EGR electrical connector.



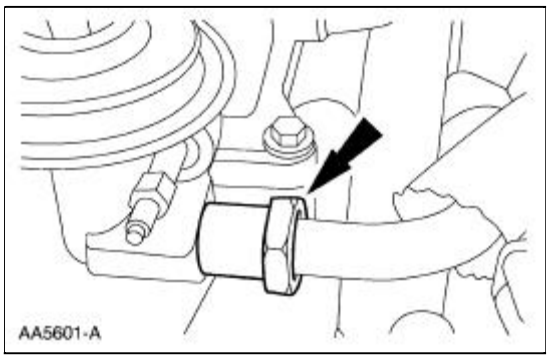
10. Disconnect the hoses from the differential pressure feedback EGR transducer (9J434).



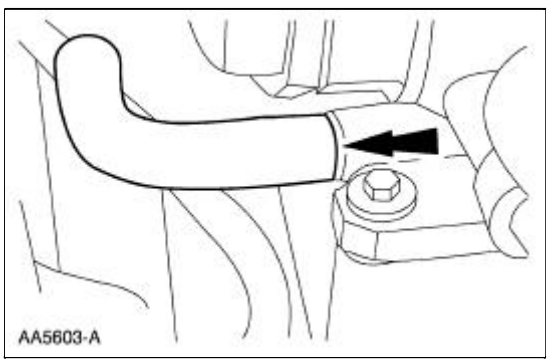
11. Remove the EGR vacuum regulator solenoid.
    1. Remove the vacuum hoses.
    2. Remove the electrical connector.
    3. Remove the bolts.



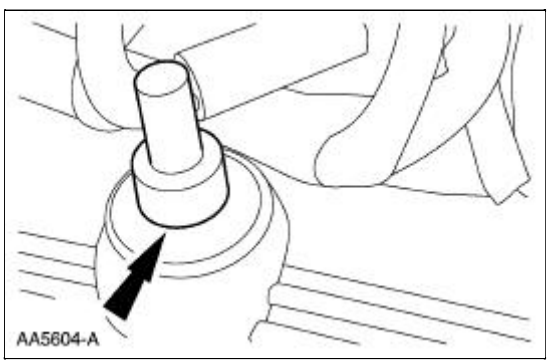
12. Disconnect the exhaust gas recirculation (EGR) tube from the EGR valve.



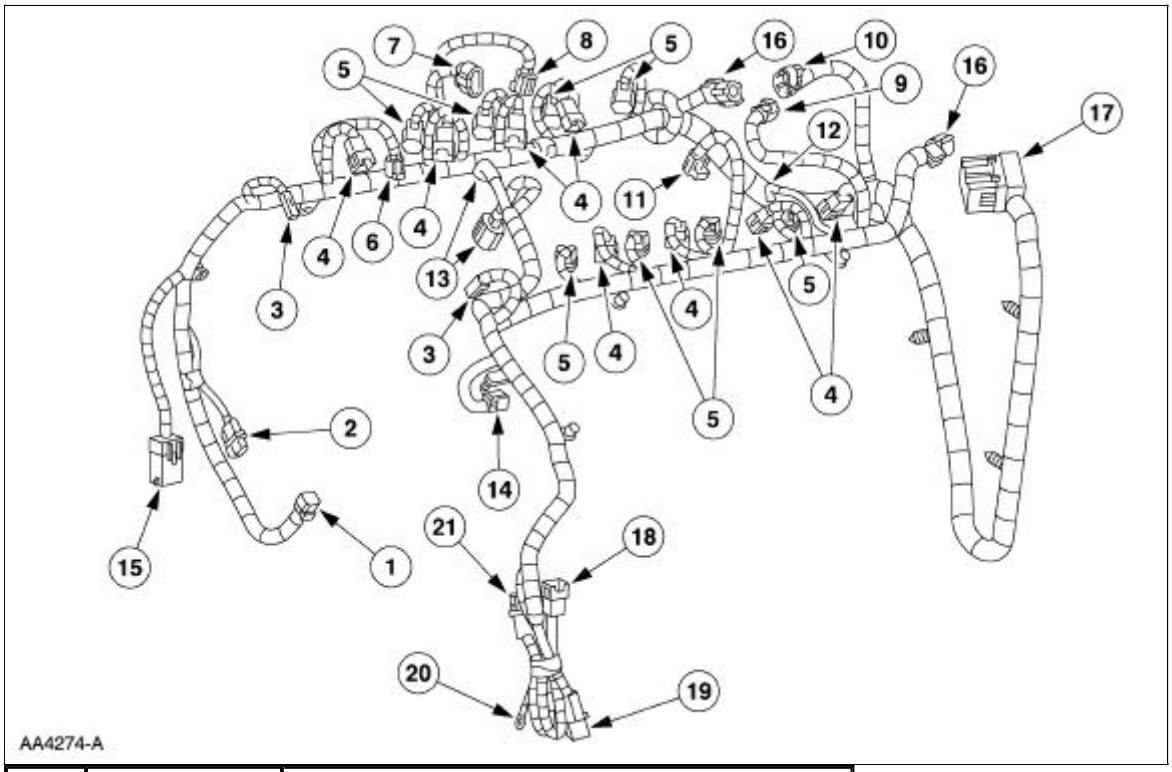
13. Disconnect the positive crankcase ventilation (PCV) hose from the base of the throttle body.



14. Disconnect the PCV valve hose.

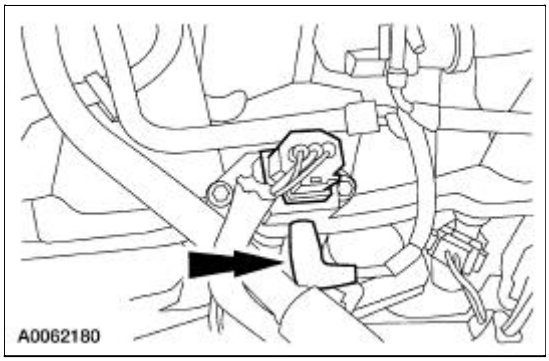


15. Remove the engine wiring harness.

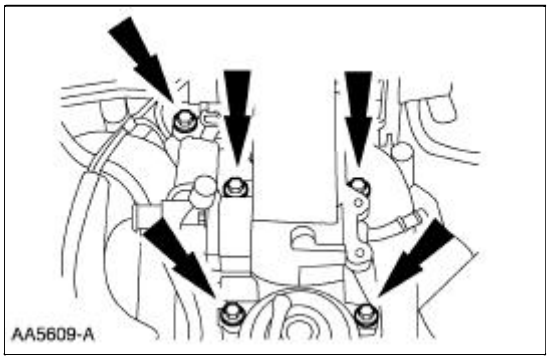


Item	Part Number	Description
1	—	To crankshaft position sensor
2	—	To A/C compressor
3	—	To radio ignition interference capacitor (2)
4	—	To fuel injectors (8)
5	—	To ignition coils (8)
6	—	To engine coolant temperature sensor
7	—	To throttle position sensor
8	—	To idle air control valve
9	—	To EGR vacuum regulator
10	—	To differential pressure feedback EGR
11	—	To fuel pressure regulator
12	—	Fuel injection ground
13	—	To generator
14	—	To camshaft position sensor
15	—	To body
16	—	To heated oxygen sensor (2)
17	—	Engine bulkhead connector
18	—	To low coolant sensor
19	—	To body
20	—	To power distribution box
21	—	To body

16. Disconnect the vacuum line to the fuel pressure sensor.



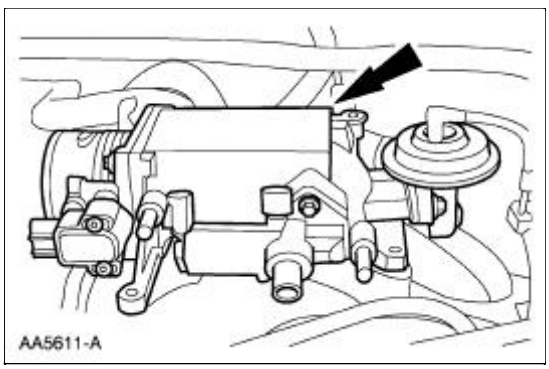
17. Remove the throttle body bolts.



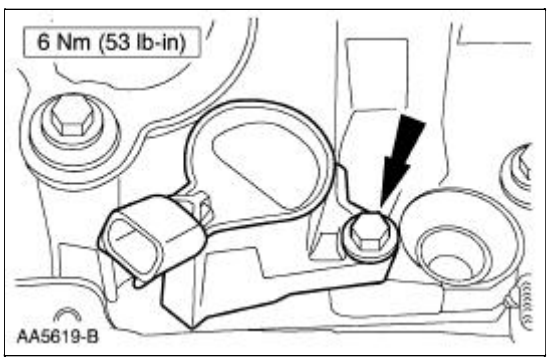
18. **NOTE:** The gasket is reusable if not damaged.

    Remove the throttle body and adapter as an assembly.

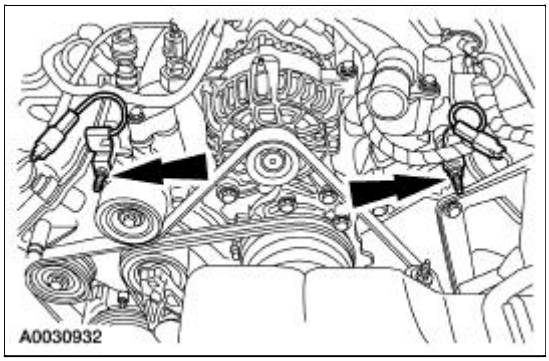
    - Inspect and clean the sealing surfaces.



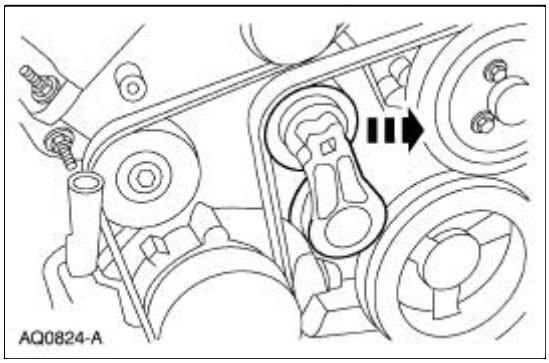
19. Remove the ignition coils.



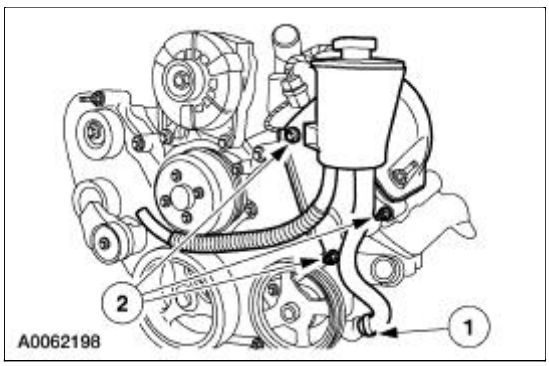
20. Remove the radio interference capacitors.



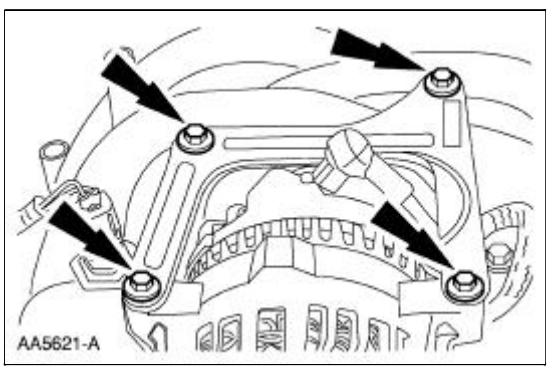
21. Rotate the belt tensioner and remove the accessory drive belt.



22. Remove the power steering reservoir bracket as an assembly.
    1. Disconnect the supply line from the pump.
    2. Remove the three bolts and reservoir.

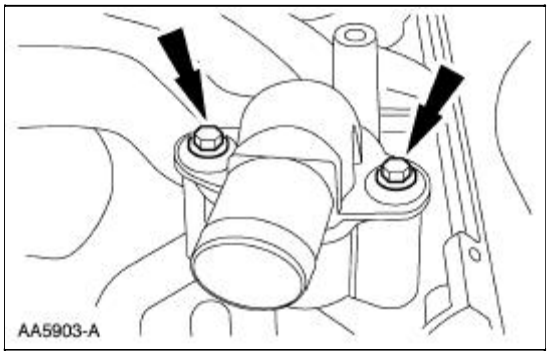


23. Remove the upper generator support bracket.

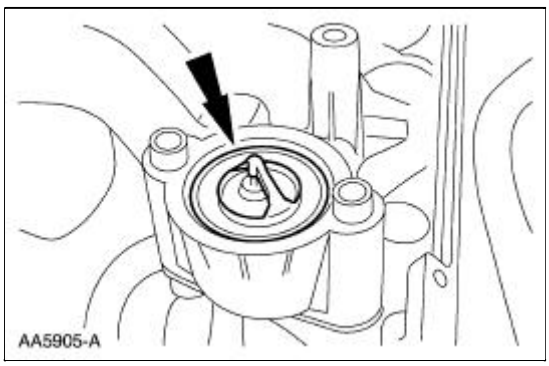


24. Remove the bolts and the generator.

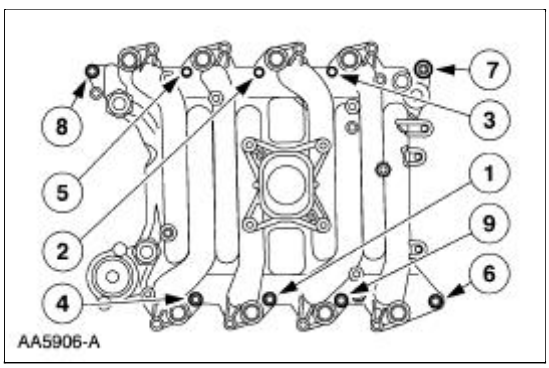
25. Remove the water outlet connector.



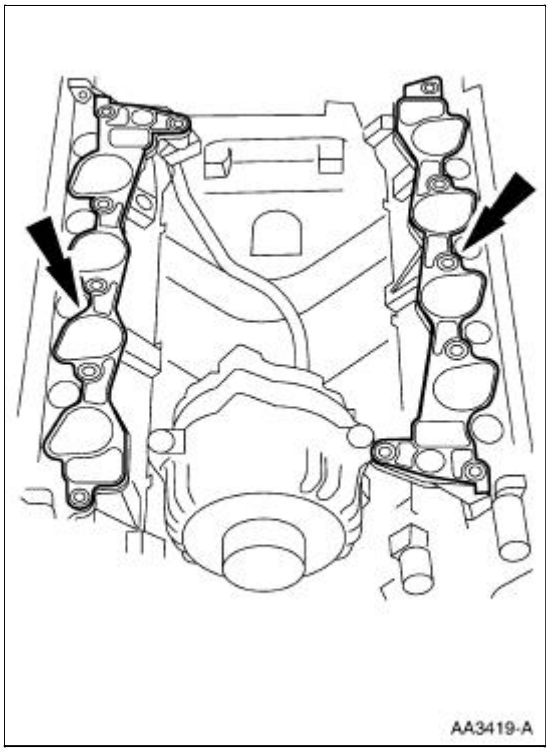
26. Remove the water thermostat and O-ring.



27. Remove the bolts in the sequence shown, and remove the intake manifold.

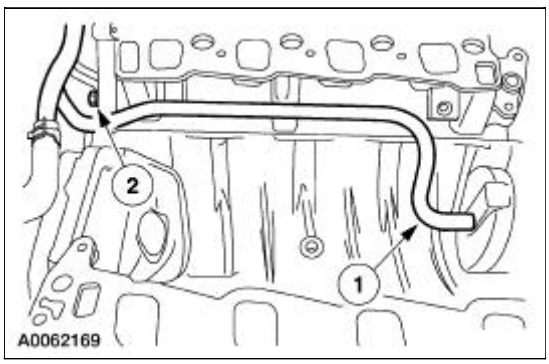


28. Remove the intake manifold gaskets.



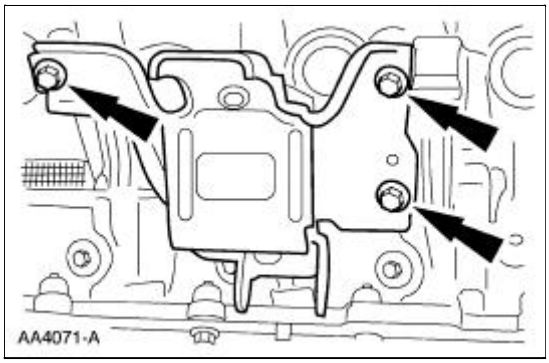
29. **CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other means to clean sealing surfaces. These tools cause scratches and gouges which make leak paths.**

    Remove the water bypass tube.
    1. Remove the nut.
    2. Remove the water bypass tube.



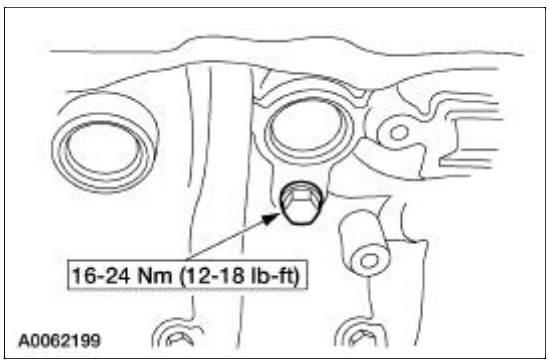
30. **NOTE:** RH shown, LH similar.

    Remove the RH and the LH engine mount.

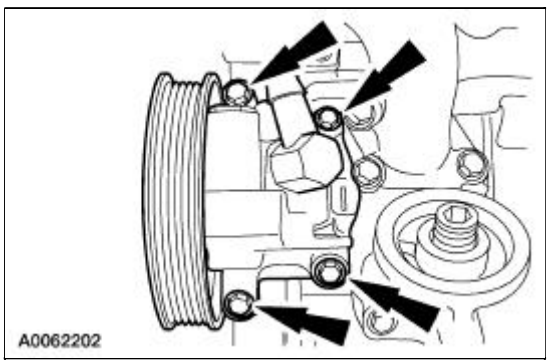


31. **NOTE:** One side shown, other side similar.

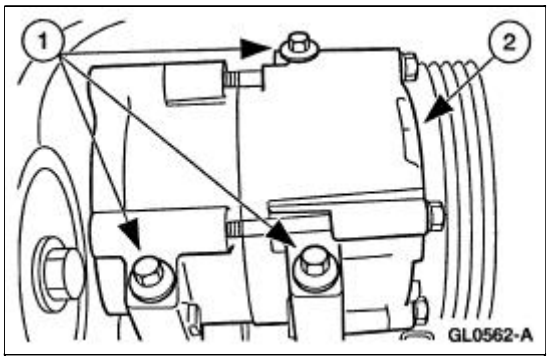
    Using a suitable container, drain coolant from the engine block.
    - Install the drain plugs when finished.



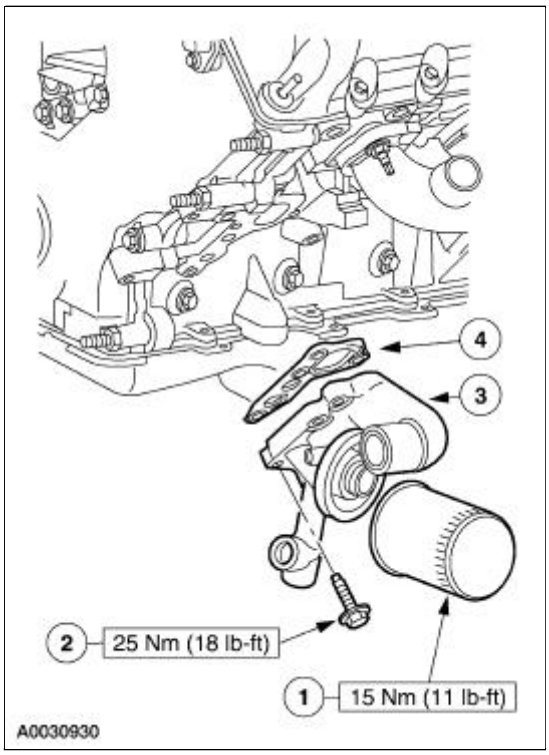
32. Remove the four bolts and the power steering pump.



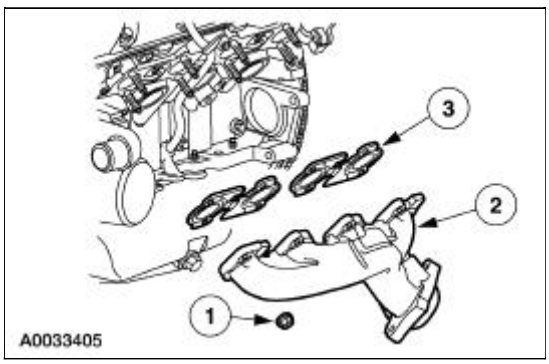
33. Remove the compressor.
    1. Remove the bolts.
    2. Remove the compressor.



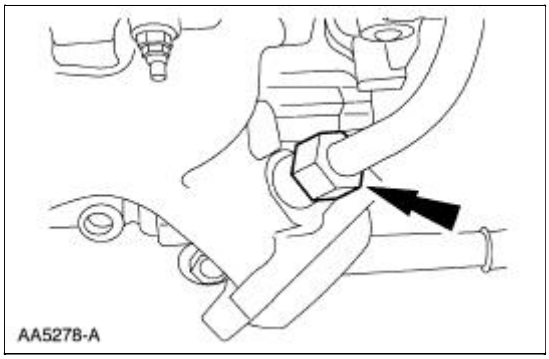
34. Remove the oil filter adapter.
    1. Remove the oil bypass filter.
    2. Remove the bolts.
    3. Remove the oil filter adapter.
    4. Clean and inspect the sealing surfaces.



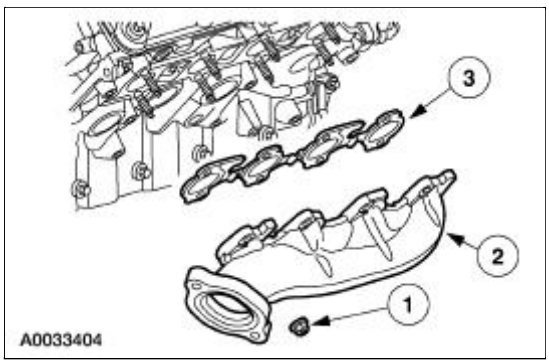
35. Remove the LH exhaust manifold.
    1. Remove the exhaust manifold nuts.
    2. Remove the exhaust manifold.
    3. Remove the exhaust manifold gasket and discard.



36. Disconnect the exhaust recirculation (EGR) tube (9D477) at the exhaust manifold.

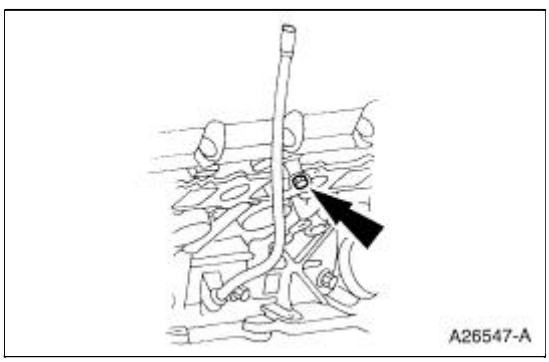


37. Remove the RH exhaust manifold.
    1. Remove the exhaust manifold nuts.
    2. Remove the exhaust manifold.
    3. Remove the exhaust manifold gasket and discard.

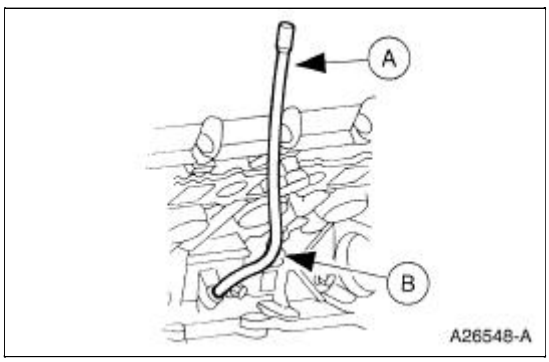


38. Clean and inspect the exhaust manifolds. For additional information, refer to Section 303-00 .

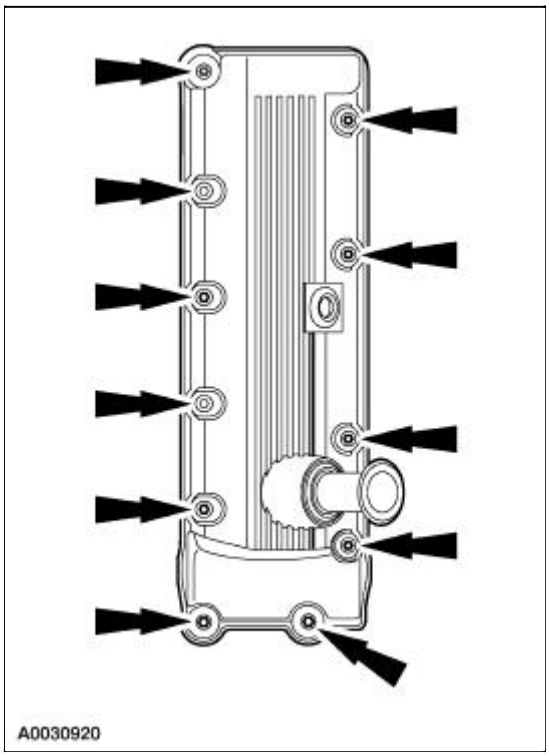
39. Remove the oil level indicator tube bolt.



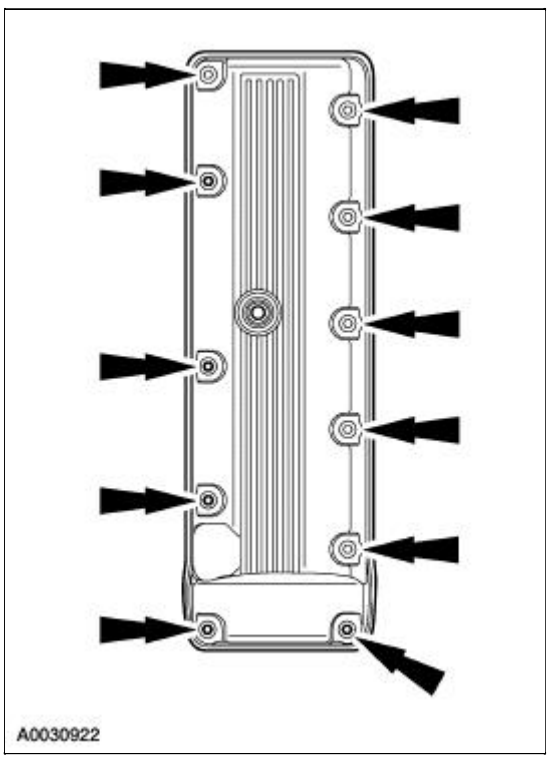
40. Remove the bolt and the oil level indicator tube.



41. Remove valve cover.
    - Remove the fasteners.
    - Remove the valve cover.



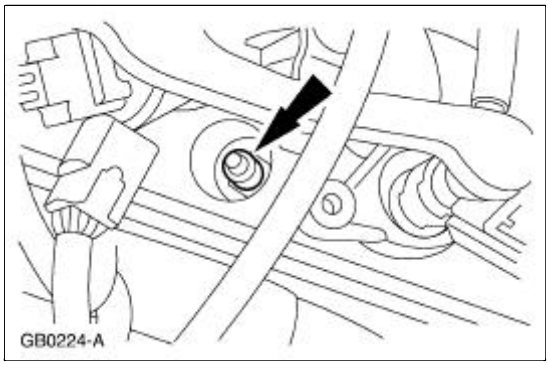
42. Remove valve cover.
    - Remove the fasteners.
    - Remove the valve cover.



43. **NOTE:** Use compressed air to remove any foreign material from the spark plug well before removing the spark plugs (12405).

    NOTE: One spark plug is shown; others are similar.

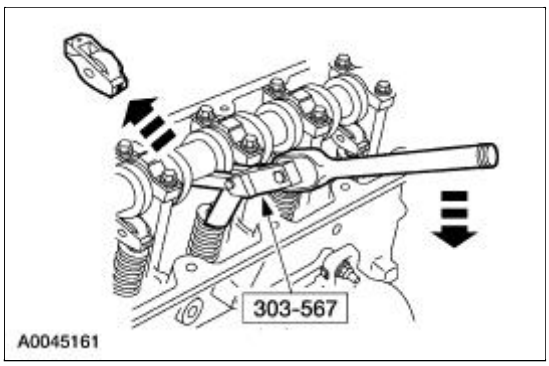
    Remove the spark plugs.



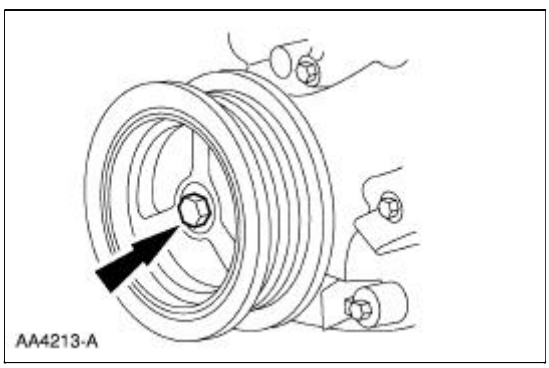
44. **NOTE:** Rotate the camshaft to the base circle of the camshaft lobe before removing followers. Keep roller followers in order when removing.

    Use special tool to compress the valve springs (6513) and remove the 16 camshaft roller followers.

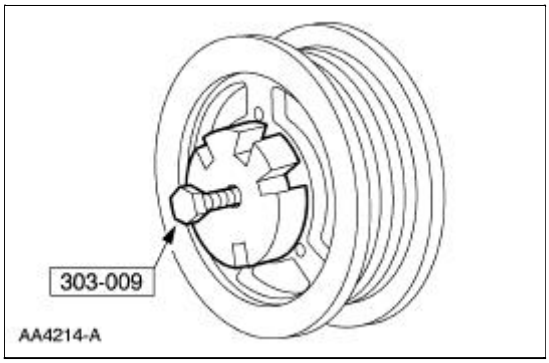
    - Rotate the camshaft and the crankshaft as necessary.



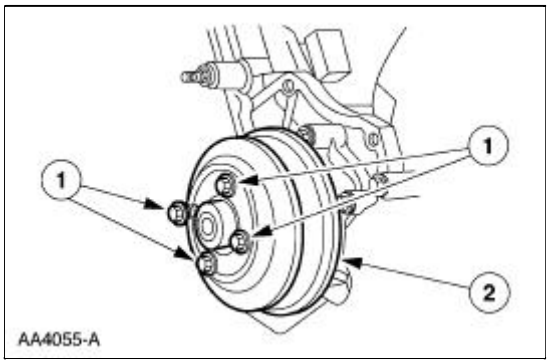
45. Remove the crankshaft pulley bolt.



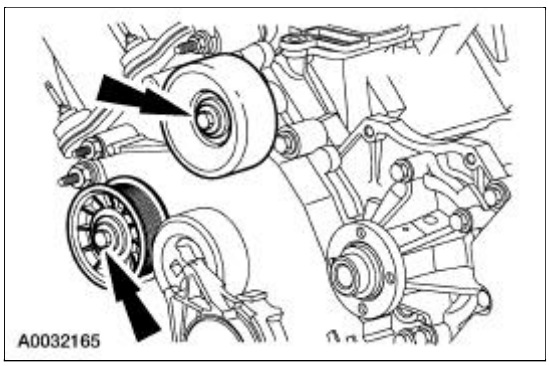
46. Using the special tool, remove the crankshaft pulley.



47. Remove the water pump pulley.
    1. Remove the water pump pulley bolts.
    2. Remove the water pump pulley.



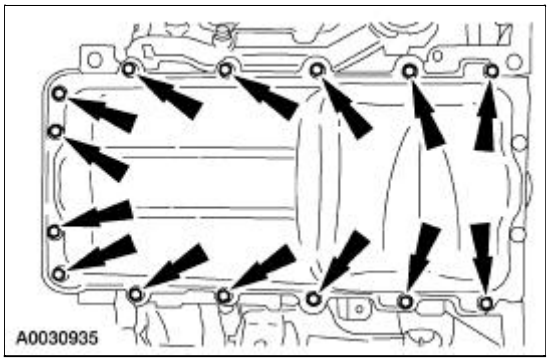
48. Remove the bolts and belt idler pulleys.



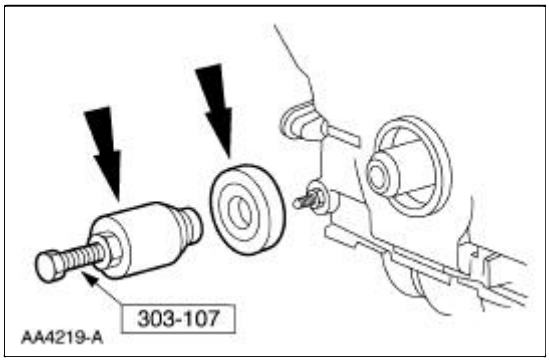
49. **NOTE:** The gasket can be reused if not damaged.

    Remove the oil pan.

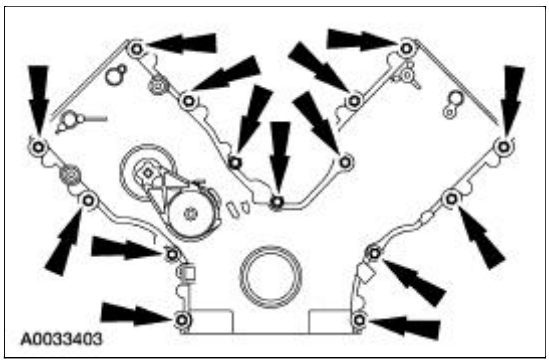
    - Remove the bolts.
    - Remove the oil pan.



50. Using the special tool, remove the front cover seal.

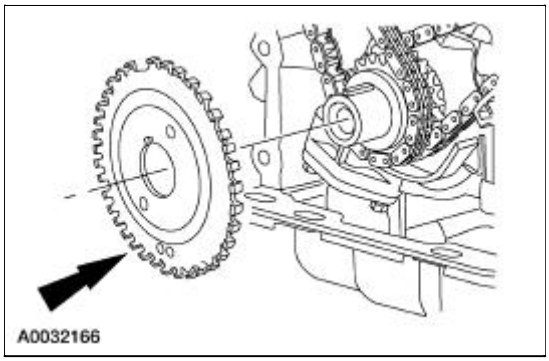


51. Remove the bolts, the studs, and the engine front cover.
    - Discard the gaskets. Clean and inspect the sealing surfaces.

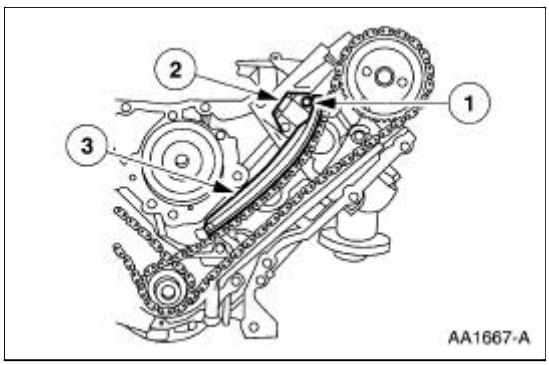


CAUTION: Since the engine is not free-wheeling, if the crankshaft or the camshafts are moved in any manner during removal and installation, the crankshaft and the camshafts must be re-synchronized.

52. Remove the crankshaft sensor ring from the crankshaft.



53. Remove the RH and LH timing chain tensioner (RH shown, LH similar).
    1. Remove the bolts.
    2. Remove the timing chain tensioners.
    3. Remove the timing chain tensioner arms.

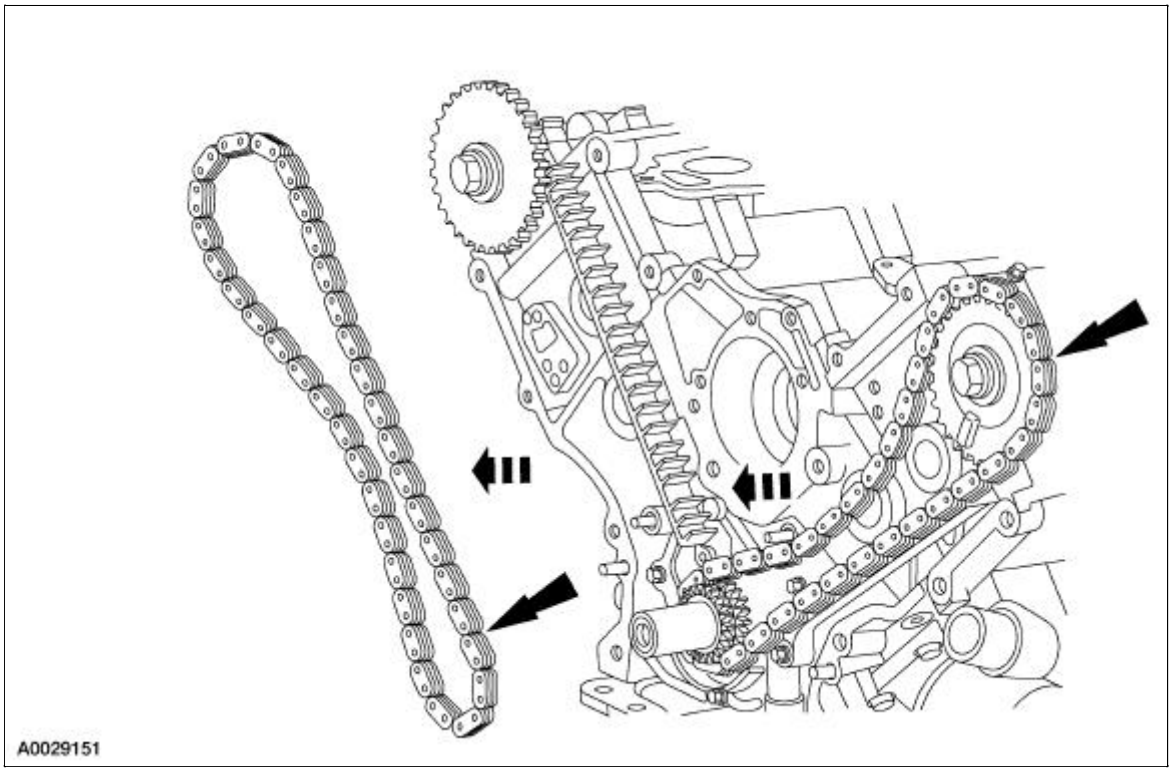


54. **CAUTION: Unless otherwise instructed, at no time when the timing chains are removed and the cylinder heads are installed is the crankshaft or the camshaft to be rotated. Severe piston and valve damage can occur.**

CAUTION: Do not remove the special tool from the camshafts.

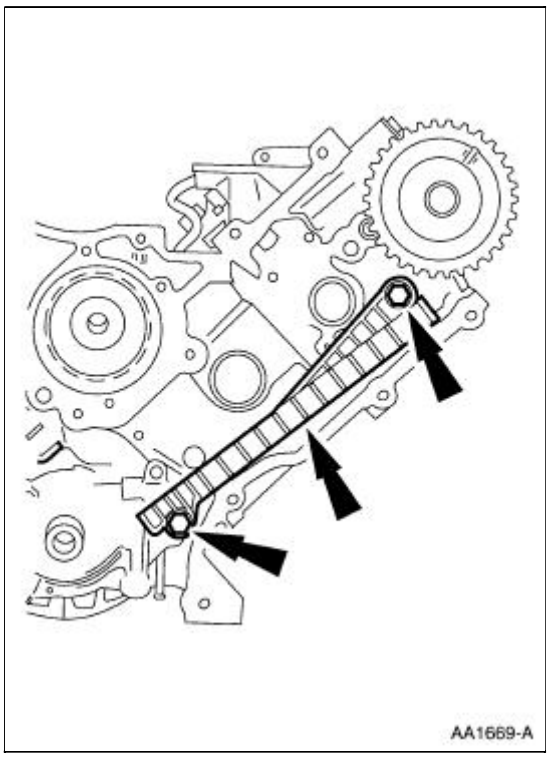
Remove the LH and RH timing chains and the crankshaft sprocket.

- Remove the RH timing chain from the camshaft sprocket.
- Remove the RH timing chain from the crankshaft sprocket.
- Remove the LH timing chain from the camshaft sprocket.
- Remove the LH timing chain from the crankshaft sprocket.



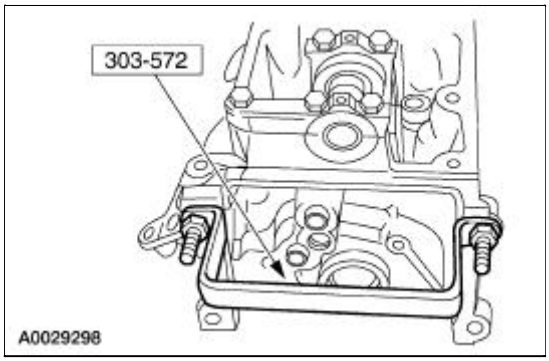
55. **NOTE:** The LH is shown and the RH is similar.

    Remove the bolts and the timing chain guides.



56. **NOTE:** One side shown, other side similar.

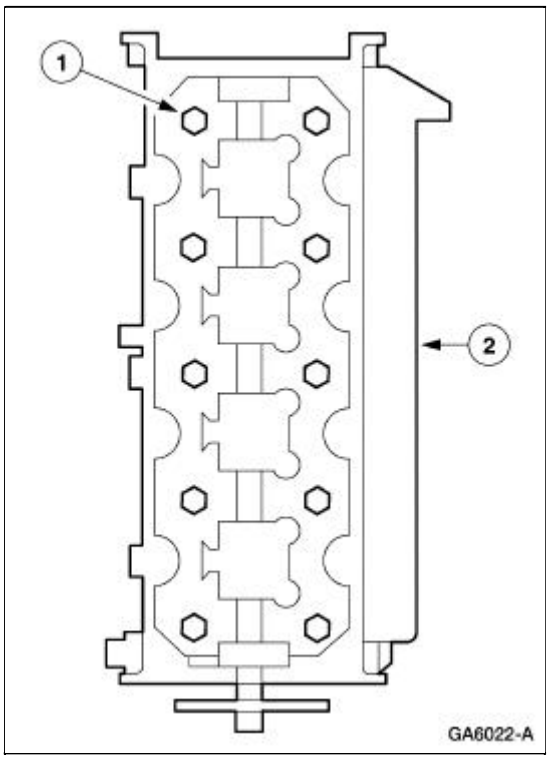
    Install the lifting handles to the RH and LH cylinder heads.



57. **CAUTION: New cylinder head bolts must be installed. They are tighten-to-yield designed and cannot be reused.**

CAUTION: Place cylinder head on cardboard or wood surface to prevent damage to the joint face.

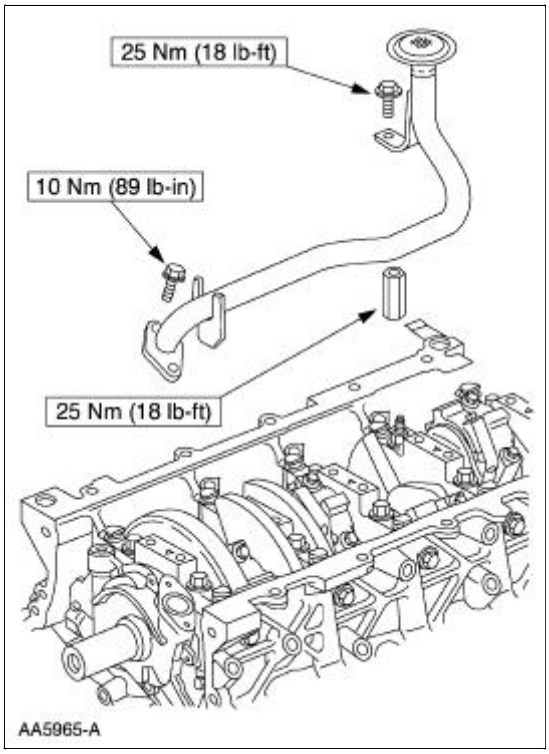
Remove the RH and LH cylinder heads.
1. Remove the bolts.
2. Remove the cylinder heads.



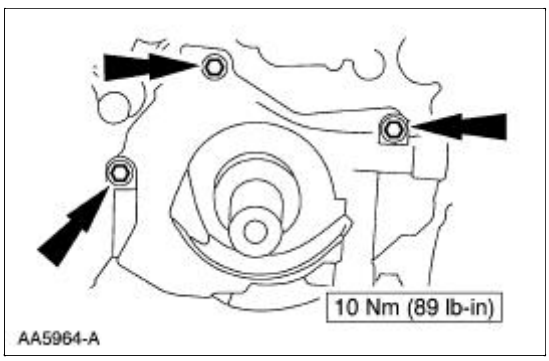
58. **CAUTION: Do not use metal scrappers, wire brushes, power abrasive discs or other abrasive means to clean gasket surfaces. These tools cause scratches and gouges that make leak paths. Use a plastic scrapping tool to remove all traces of the head gasket (6051).**

Clean and inspect all of the sealing surfaces. For additional information, refer to Section 303-00 .

59. Remove the oil pump screen cover and tube, and the spacer.



60. Remove the oil pump.

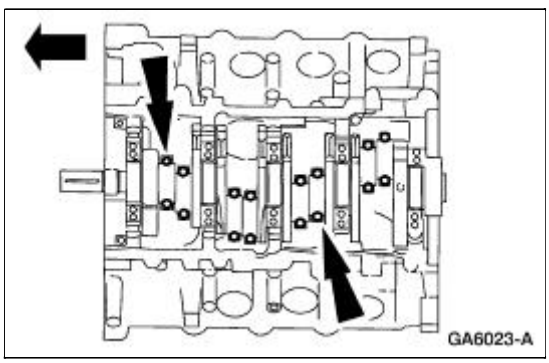


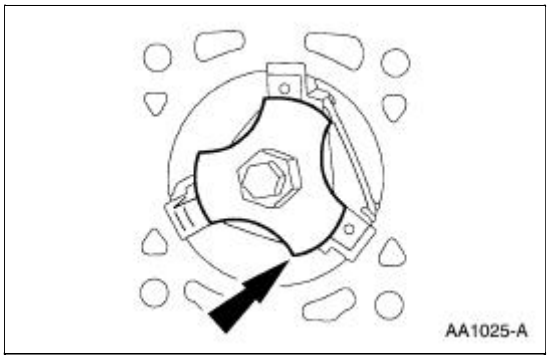
61. **CAUTION: Do not stamp the top of pistons, as ring land damage can occur.**

NOTE: Connecting rods and rod caps should be numbered to retain correct orientation.

Remove the connecting rod caps for piston numbers 1 and 6.

- Discard the bolts.

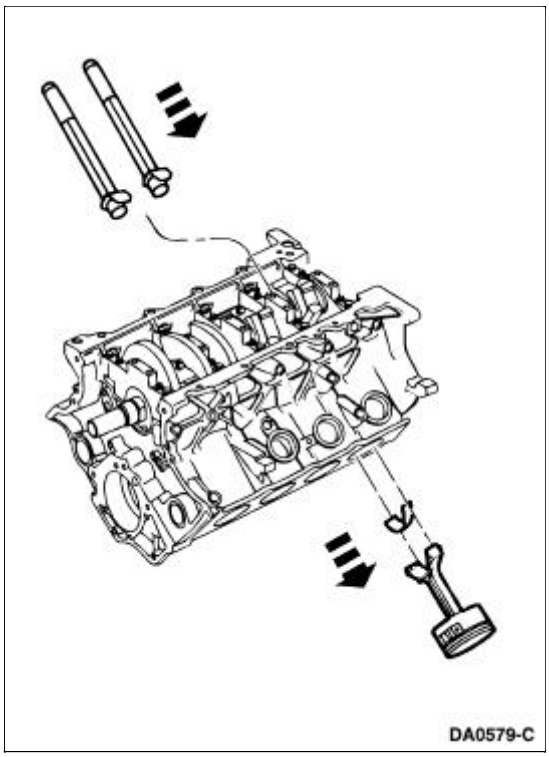




62. **CAUTION: Do not scratch cylinder walls or crankshaft journals with the connecting rod.**

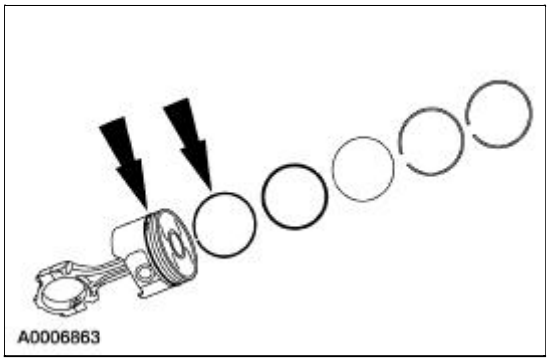
    NOTE: Before removing pistons, inspect the top of the cylinder bores. If necessary, remove the ridge or carbon deposits from each cylinder using a cylinder ridge reamer following the manufacturer's instructions.

    Remove the piston removing pistons number 1 and 6 through the top of the cylinder block.



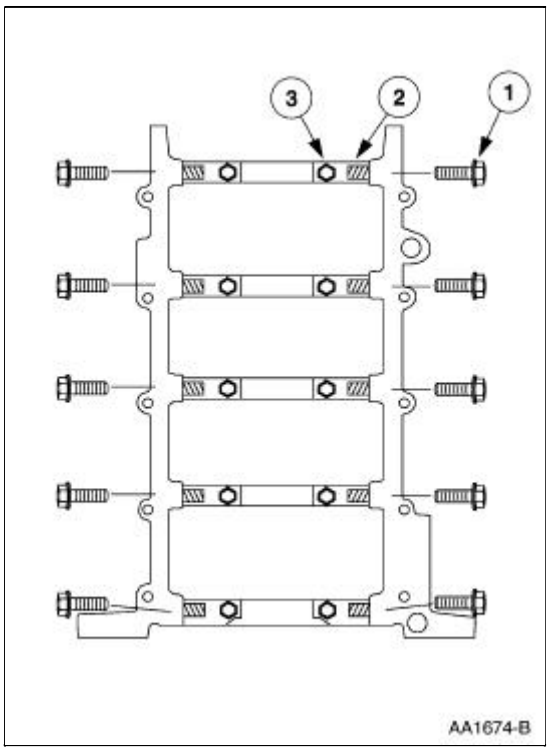
63. Repeat the previous two steps to remove the remaining pistons, rotating the crankshaft 90 degrees between piston pairs 3 and 5, 4 and 7, 2 and 8.

64. Remove the piston rings.

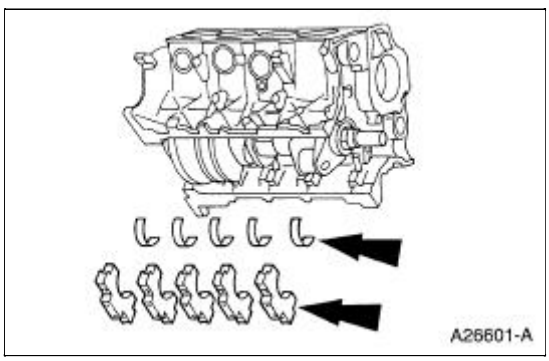


65. Clean and inspect pistons. For additional information, refer to Section 303-00 .

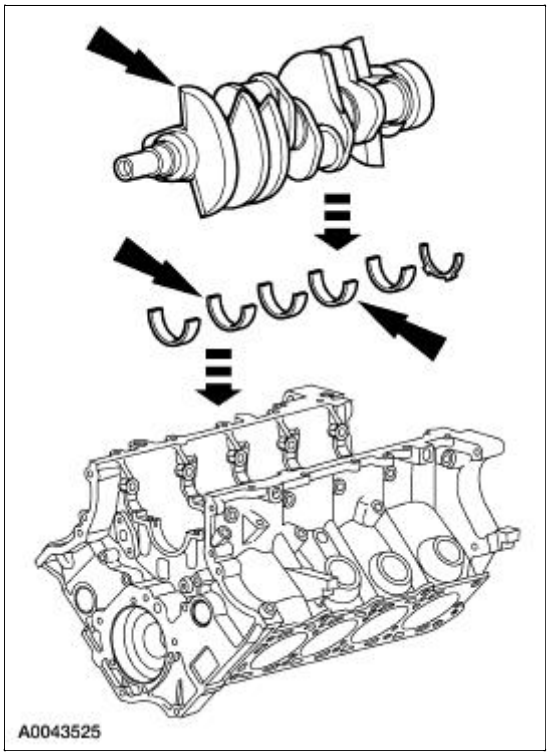
66. Remove the crankshaft bearing cap fasteners.
    1. Remove and discard the cross-mounted main cap bolts.
    2. Loosen the jackscrews.
    3. Remove and discard the main cap bolts.



67. Remove the main bearing cap and the crankshaft main bearings from the cylinder block.

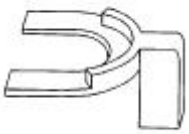


68. Remove the crankshaft, crankshaft main bearings and the thrust washer.


A0043525

Cylinder Head

Special Tool(s)

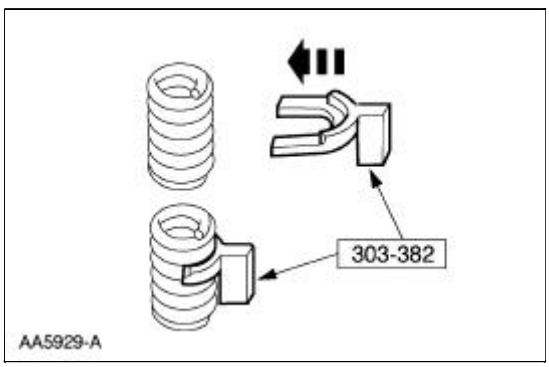
ST1330-A	Compressor, Valve Spring 303-381(T91P-6565-A)
 ST1331-A	Compressor Spacer, Valve Spring 303-382 (T91P-6565-AH)
ST1332-A	Installer, Valve Stem Oil Seal 303-383 (T91P-6571-A)

Material

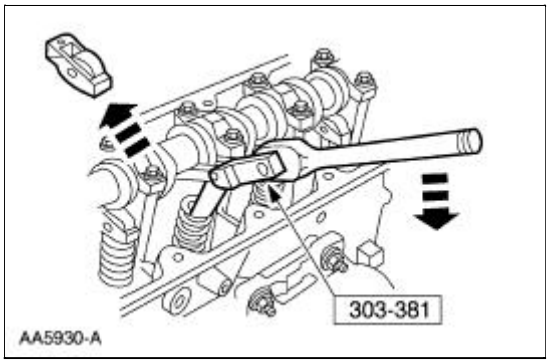
Item	Specification
Super Premium SAE 5W-20 Motor Oil 5W20-QSP or equivalent	WSS-M2C153-H

Disassembly

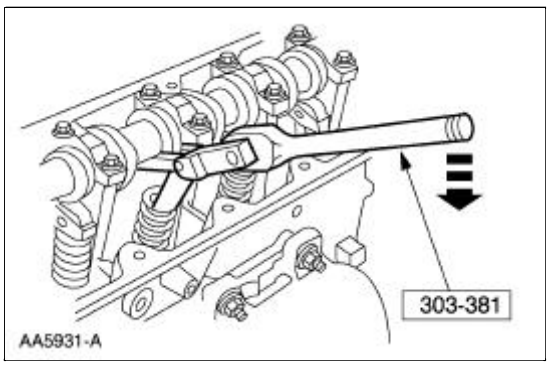
1. Install the special tool.



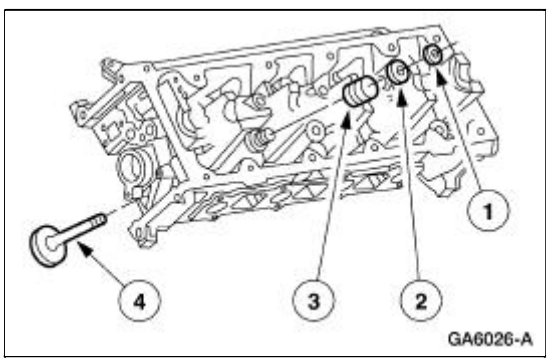
2. Using the special tool, remove the roller followers.



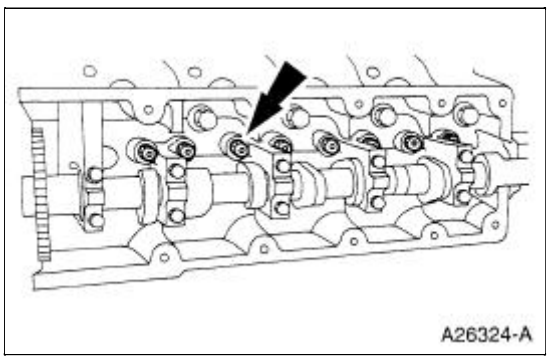
3. Using the special tool, compress the valve spring.



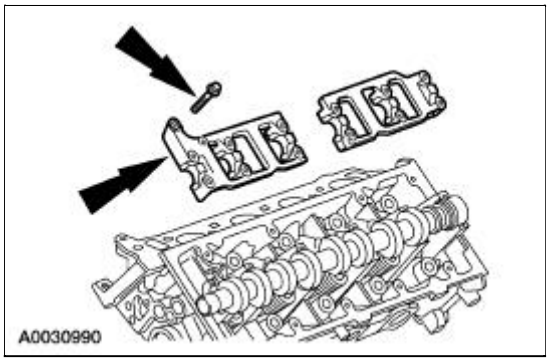
4. Remove the valves.
    1. Remove the valve spring retainer keys.
    2. Remove the valve spring retainers.
    3. Remove the valve spring.
    4. Remove the valves.



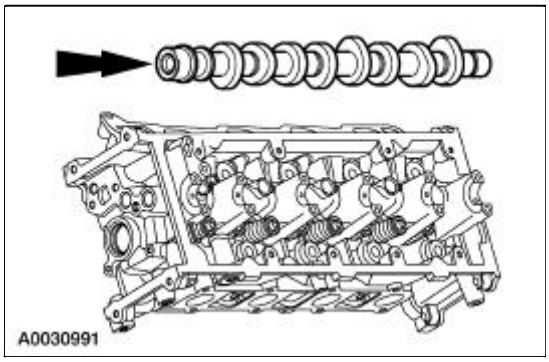
5. Remove the hydraulic lash adjusters.



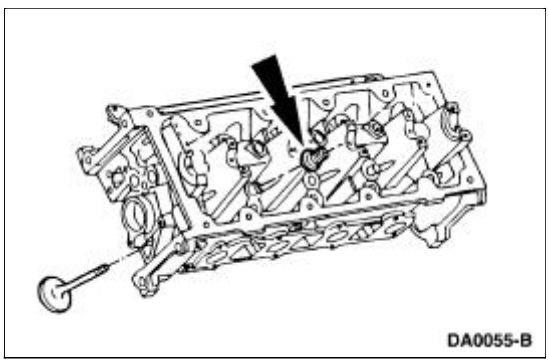
6. Remove the bolts and the camshaft bearing caps.



7. Remove the camshaft (6250).



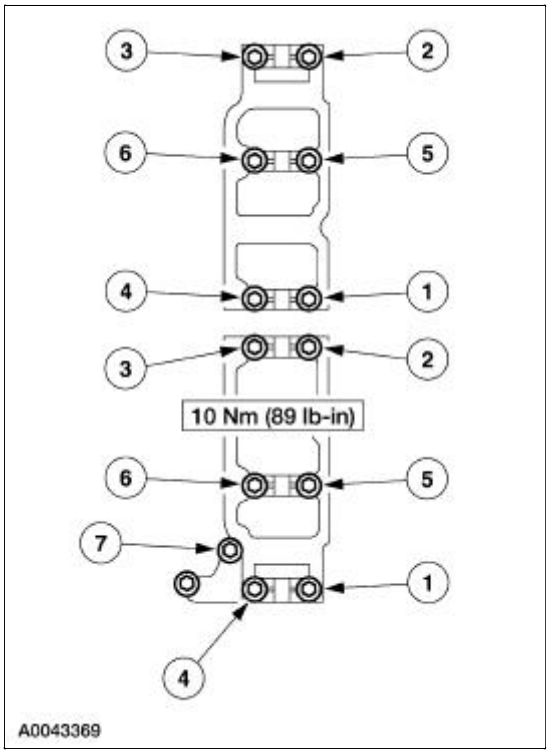
8. Remove the valve stem seals.



Assembly

1. **NOTE:** Lubricate all moving parts with clean engine oil prior to assembly.

   To install, reverse the removal procedure.


3
2
6
5
4
1
3
2
10 Nm (89 lb-in)
6
5
7
1
4
A0043369

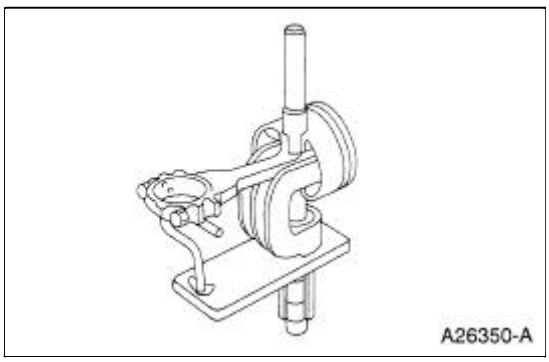
Piston

Material

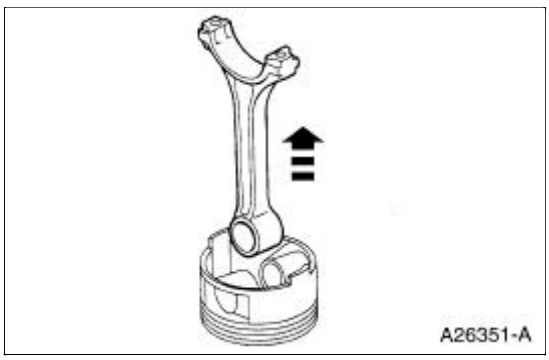
Item	Specification
Super Premium SAE 5W-20 Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Disassembly

1. Press the piston pin out of the connecting rod and piston assembly.



2. Remove the connecting rod from the piston.

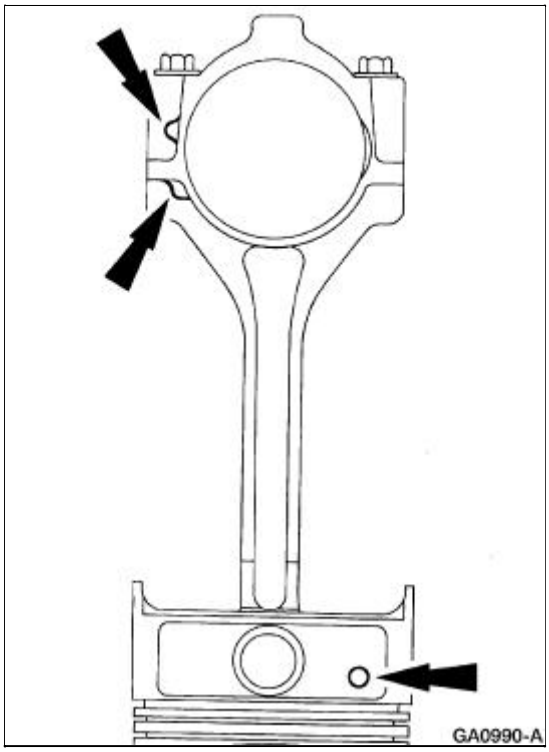


3. Clean and inspect the piston and connecting rod. For additional information, refer to Section 303-00 .

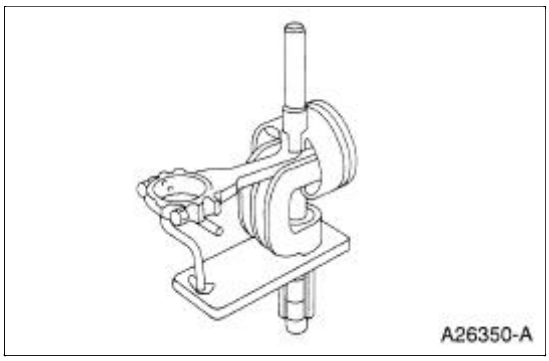
Assembly

1. **NOTE:** Connecting rod must be installed into piston with identification markings toward front.

   Position the connecting rod in the piston.



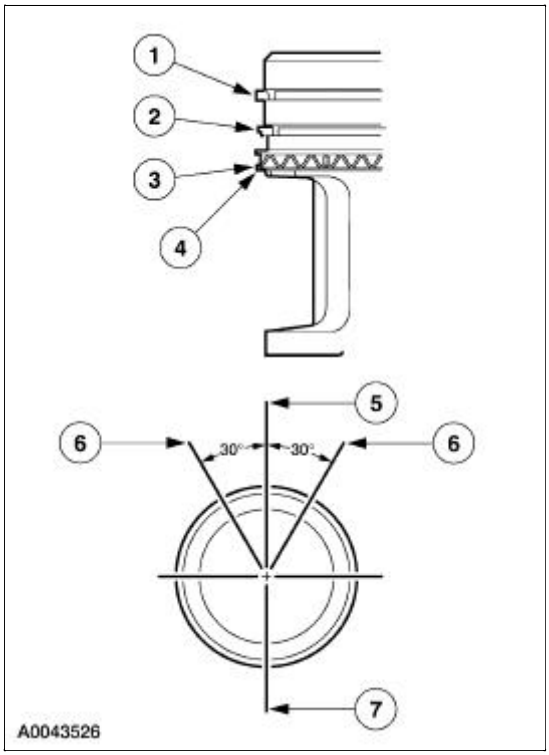
2. Press the piston into the piston and connecting rod assembly.



3. Install the piston rings.
    1. Using a suitable ring expander tool install the upper compression ring with the top side identification mark towards the dome.
    2. Using a suitable ring expander tool install the lower compression ring with the top side identification mark towards the dome.
    3. **NOTE:** Assemble with end gaps up.

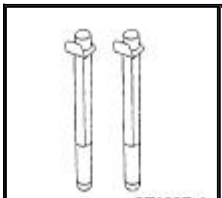
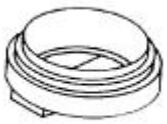
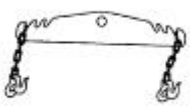
       Using a suitable tool install the piston oil control segment ring spacer.
    4. **NOTE:** Install one segment ring above and one segment ring below the spacer.

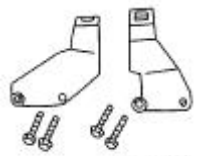
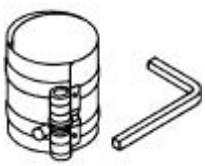
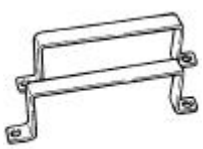
       Using a suitable tool install the piston oil control segment rings.
    5. Orient the upper compression ring gap to the center line at the rear of the piston, parallel to the wrist pin bore.
    6. Orient the oil control ring gaps as shown.
    7. Orient the expander ring gap and lower compression ring gap as shown.


1
2
3
4
5
6
30°
30°
6
7
A0043526

Engine

Special Tool(s)

 ST1337-A	Guides, Connecting Rod 303-442 (T93P-6136-A)
ST1480-A	Installer, Crankshaft Rear Oil Seal 303-518 (T95P-6701-DH)
 ST1479-A	Installer, Crankshaft Rear Oil Seal 303-516 (T95P-6701-BH)
ST1482-A	Installer, Crankshaft Rear Oil Slinger 303-517 (T95P-6701-CH)
ST1185-A	Impact Slide Hammer 100-001 (T50T-100-A)
 ST1602-A	Spreader Bar 303-D089 (D93P-6001-A3)
ST1604-A	Lifting Bracket, Engine 303-D087 (D93P-6001-A1)
	Lifting Bracket, Engine 303-D088 (D93P-6001-A2)

ST1603-A	
 ST1701-A	Lifting Bracket Set, Engine 303-D074 (D91P-6001-A)
ST1287-A	Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)
ST1328-A	Installer, Front Cover Oil Seal 303-335 (T88T-6701-A)
	Compressor, Piston Ring 303-D032 (D81L-6002-C) or equivalent
ST1335-A	Holding Tool, Crankshaft 303-448 (T93P-6303-A)
 ST1668-A	Remover/Installer, Cylinder Head 303-572 (T97T-6000-A)
ST1330-A	Compressor, Valve Spring 303-576 (T97P-6565-AH)
	Strap Wrench 303-D055 (D85L-6000-A) or equialent

ST1438-A	
ST2197-A	Crankshaft Seal Installer 303-635

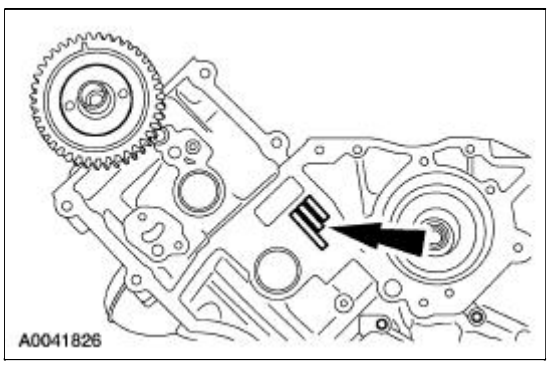
Material

Item	Specification
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4
Super Premium SAE 5W-20 Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

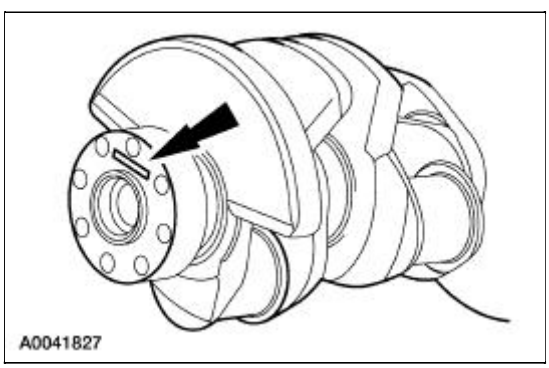
Assembly

NOTE: During engine assembly, it may by necessary to check bearing clearances and end play. For additional information, refer to Section 303-00 .

1. Record the main bearing code found on the front of the engine block.



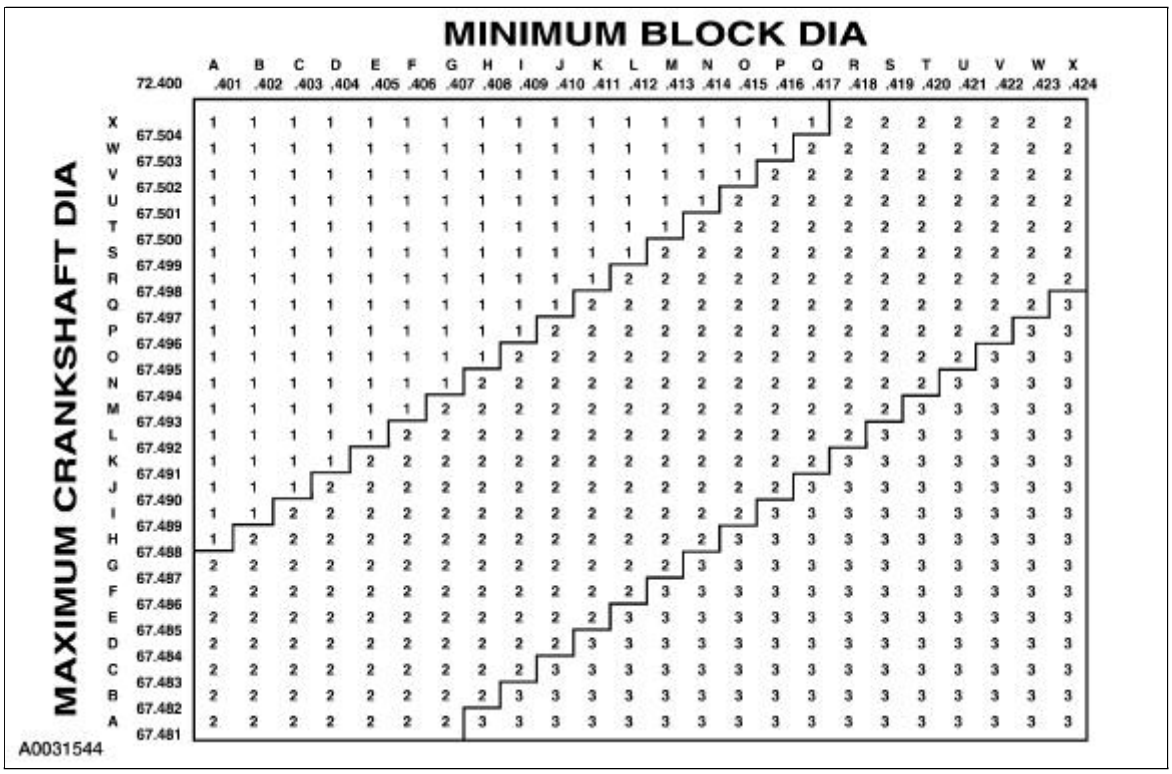
2. Record the main bearing code found on the back of the crankshaft.



3. Using the data recorded earlier and the Bearing Select Fit Chart, Standard Bearings Chart

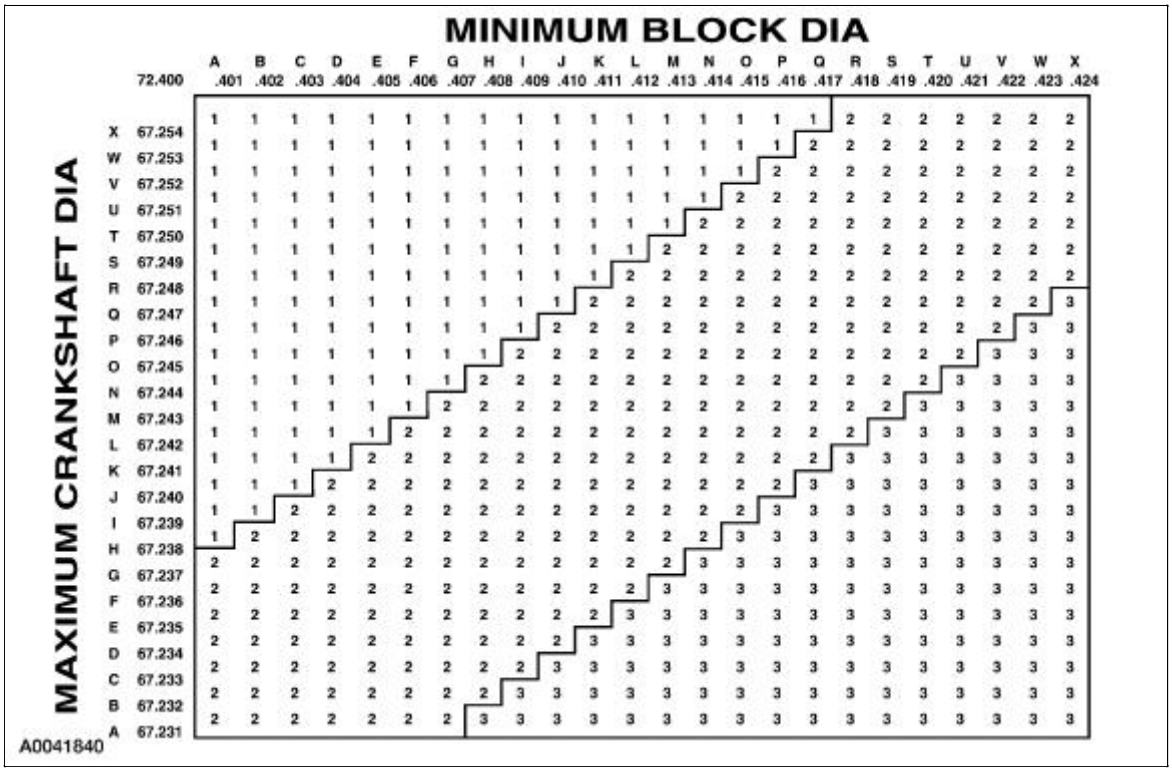
determine the required bearing grade for each main bearing.

- Read the first letter of the engine block main bearing code and the first letter of the crankshaft main bearing code.
- Read down the column below the engine block main bearing code letter, and across the row next to the crankshaft main bearing code letter, until the two intersect. This is the required bearing grade for the number one crankshaft main bearing.
- As an example, if the engine block code letter is "F" and the crankshaft code letter is "D," the correct bearing grade for this main bearing is "2."
- Repeat this process for the remaining four main bearings.



MAXIMUM CRANKSHAFT DIA	72.400	A .401	B .402	C .403	D .404	E .405	F .406	G .407	H .408	I .409	J .410	K .411	L .412	M .413	N .414	O .415	P .416	Q .417	R .418	S .419	T .420	U .421	V .422	W .423	X .424
X	67.504	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
W	67.503	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
V	67.502	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
U	67.501	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
T	67.500	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2
S	67.499	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
R	67.498	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
Q	67.497	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3
P	67.496	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
O	67.495	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
N	67.494	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
M	67.493	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
L	67.492	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
K	67.491	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
J	67.490	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
I	67.489	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3
H	67.488	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3
G	67.487	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3
F	67.486	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
E	67.485	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
D	67.484	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
C	67.483	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
B	67.482	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
A	67.481	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

4. If oversize bearings are being used, use the procedure in the previous step and the Bearing Select Fit Chart, Oversize Bearing Chart to determine the required grade for each main bearing.



	72.400	A .401	B .402	C .403	D .404	E .405	F .406	G .407	H .408	I .409	J .410	K .411	L .412	M .413	N .414	O .415	P .416	Q .417	R .418	S .419	T .420	U .421	V .422	W .423	X .424
X	67.254	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
W	67.253	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
V	67.252	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
U	67.251	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
T	67.250	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2
S	67.249	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
R	67.248	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
Q	67.247	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3
P	67.246	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
O	67.245	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
N	67.244	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
M	67.243	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
L	67.242	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
K	67.241	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
J	67.240	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
I	67.239	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3
H	67.238	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3
G	67.237	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3
F	67.236	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
E	67.235	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
D	67.234	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
C	67.233	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
B	67.232	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
A	67.231	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

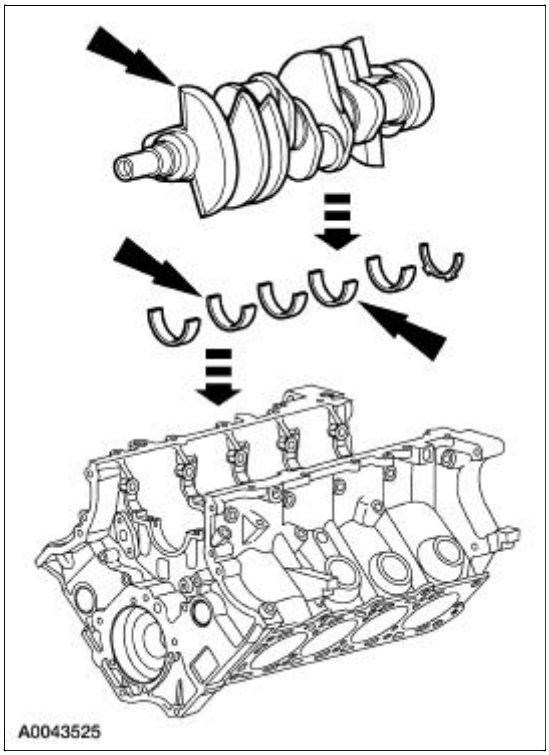
NOTE: Before assembling the cylinder block, all sealing surfaces must be free from chips, dirt, paint and foreign material. Also, make sure the coolant and oil passages are clear.

5. Install the crankshaft upper main bearings into the cylinder block and lubricate them with clean engine oil.

6. **NOTE:** Do not install the upper thrust washer until the crankshaft is installed. Refer to Step 3.

   NOTE: Do not install the upper thrust washer until the crankshaft (6303) is installed. Refer to Step 3.

   Install the crankshaft onto the upper main bearings.



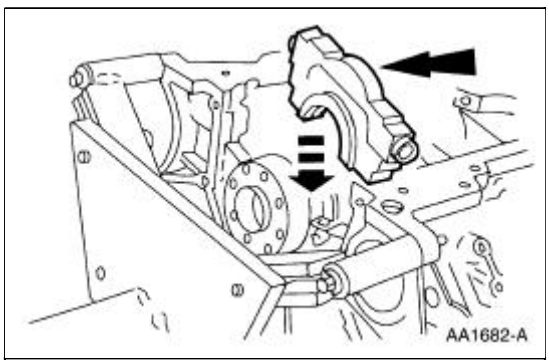
7. **NOTE:** The oil groove on the thrust washer must face toward the rear of the engine (against the crankshaft surface).

   Push the crankshaft rearward and install the crankshaft upper thrust washer at the rear of the No. 5 main boss.

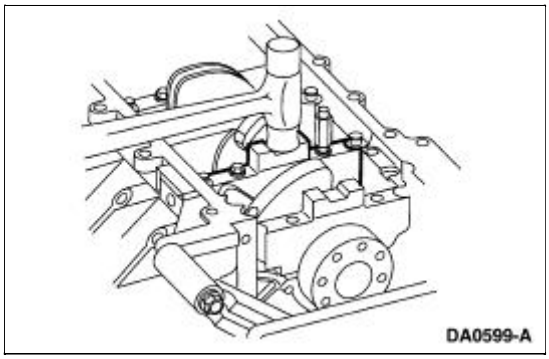
8. **NOTE:** Rotate the jackscrews into the bearing caps enough to provide clearance to the cylinder block prior to installing the bearing caps.

   Install the lower main bearings into the main bearing caps and lubricate them with clean engine oil.

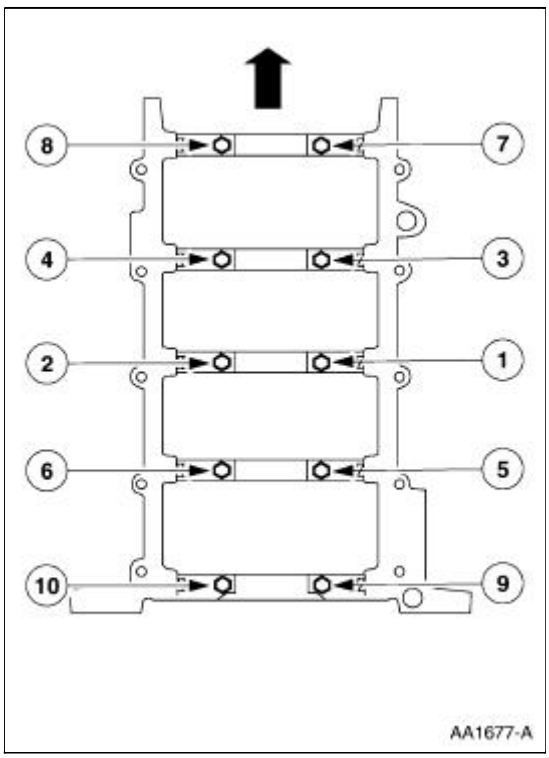
9. Install the rear main bearing cap.



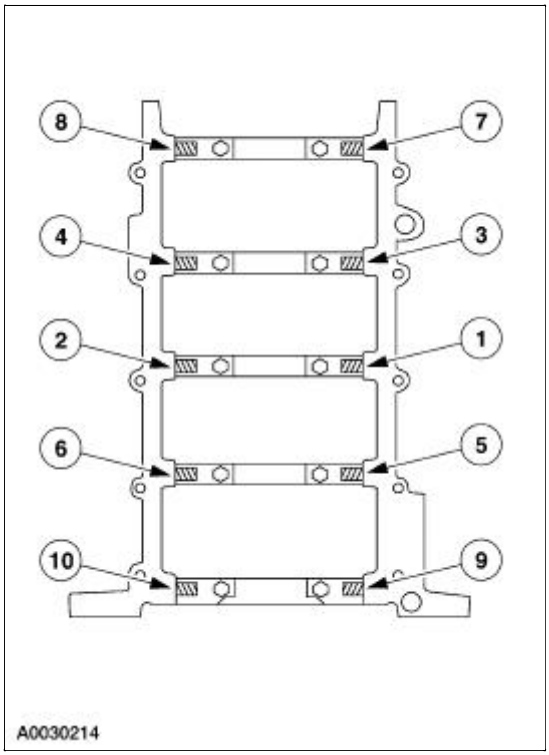
10. Install the remaining main bearing caps on the cylinder block and tap into place using a plastic or dead-blow hammer.



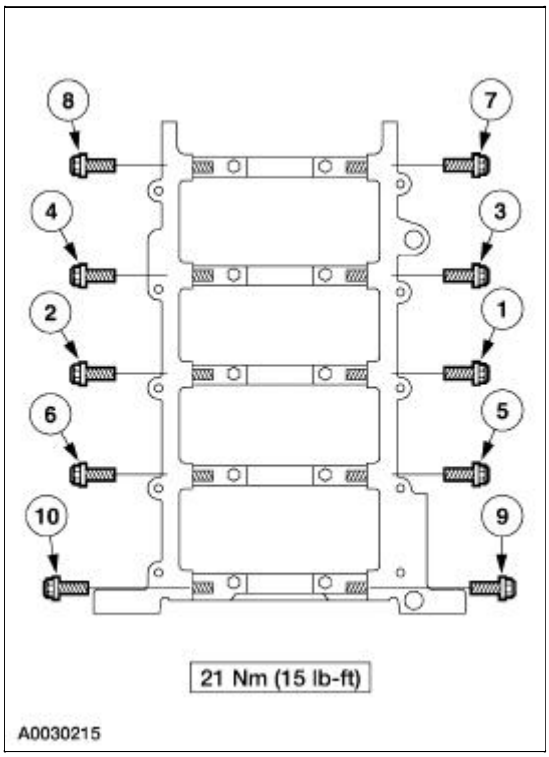
11. Install the vertical main bearing cap fasteners and tighten in the sequence shown.
    - Tighten to 40 Nm (30 lb-ft).
    - Tighten an additional 85-95 degrees.



12. Back out the jackscrews against the cylinder block in sequence shown.
    - Tighten to 5 Nm (44 lb-in).
    - Tighten to 10 Nm (89 lb-in).



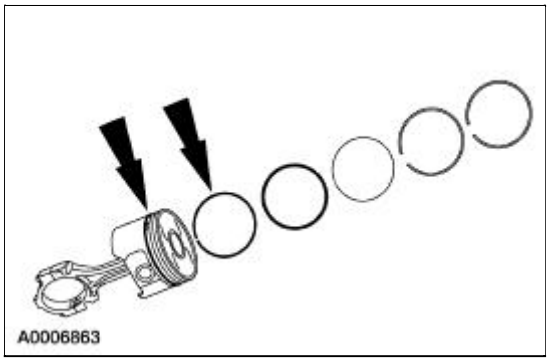
13. Install the side bolts and tighten them in the sequence shown.



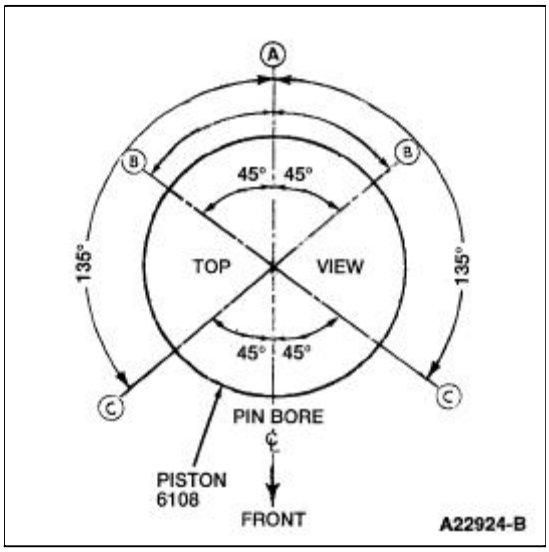
14. Check the crankshaft end play. For additional information, refer to Section 303-00 .

15. Check the piston to cylinder block and piston ring clearances. For additional information, refer to Section 303-00 .

16. Install the piston rings.



17. Make sure the ring gaps (oil spacer [A], oil ring [B], and compression ring [C]) are properly spaced around the circumference of the piston.



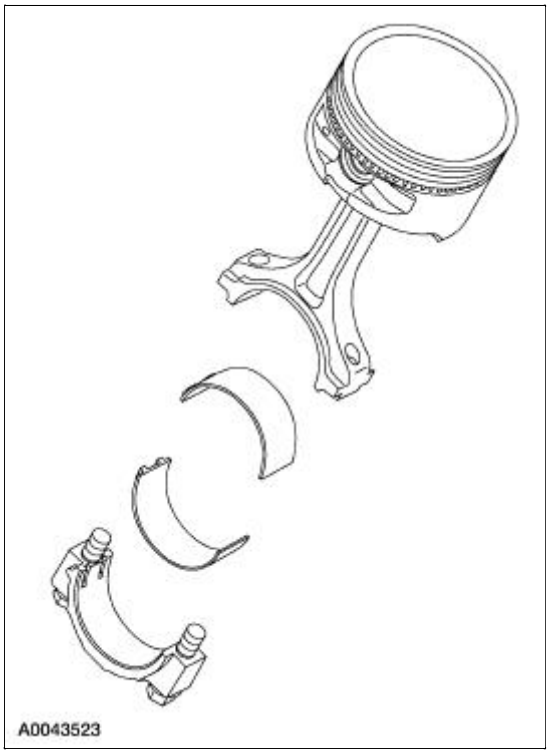
18. **CAUTION: Do not scratch the cylinder walls or the crankshaft journals with the connecting rod.**

NOTE: Only one piston and connecting rod shown, others similar.

NOTE: Make sure the crankshaft is facing forward.

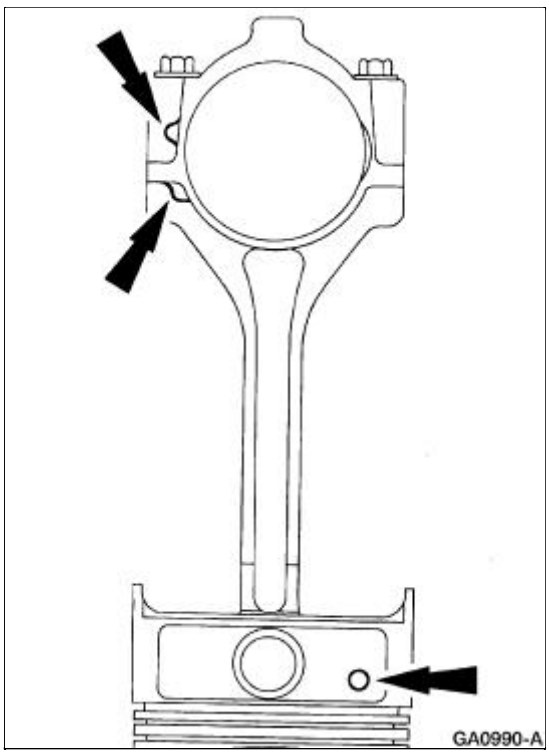
NOTE: Lubricate the piston rings, cylinder walls and connecting rod bearings with clean engine oil.

Install the upper bearings in the connecting rod as shown.



19. **NOTE:** The piston grade number will face the rear of the engine.

    Check that the piston/connecting rod assembly is oriented with the identification marks facing the front of the engine.

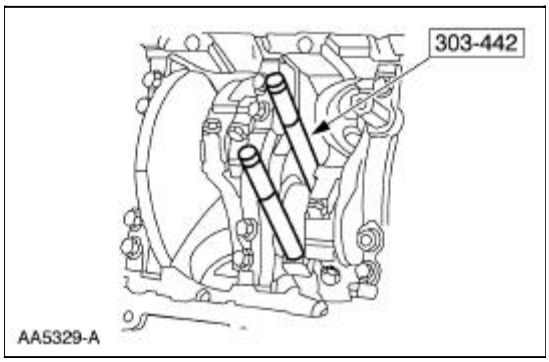


20. **CAUTION: Do not scratch the cylinder walls or the crankshaft journals with the connecting rod.**

    NOTE: Make sure the crankshaft is at TDC.

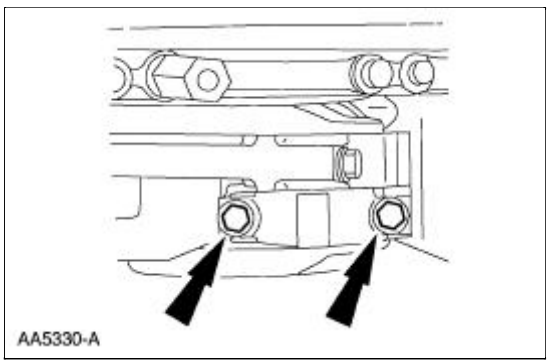
NOTE: Only one connecting rod assembly shown, others similar.

Using the special tool install the piston and connecting rod assembly by pushing the pistons through the top of the cylinder block.



21. **NOTE:** These bolts are torque-to-yield. Install new bolts each time they are serviced.

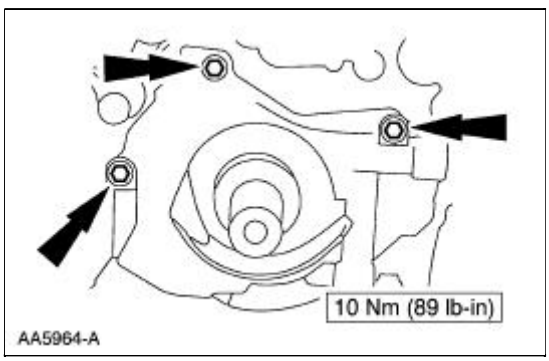
    Install the connecting rod bearing caps and bolts and tighten in three stages.
    - Stage 1: Tighten to 25Nm (18 lb-ft).
    - Stage 2: Tighten to 40Nm (30 lb-ft).
    - Stage 3: Tighten an additional 90 degrees.



22. Rotate the crankshaft and install the remaining piston and connecting rod assemblies.

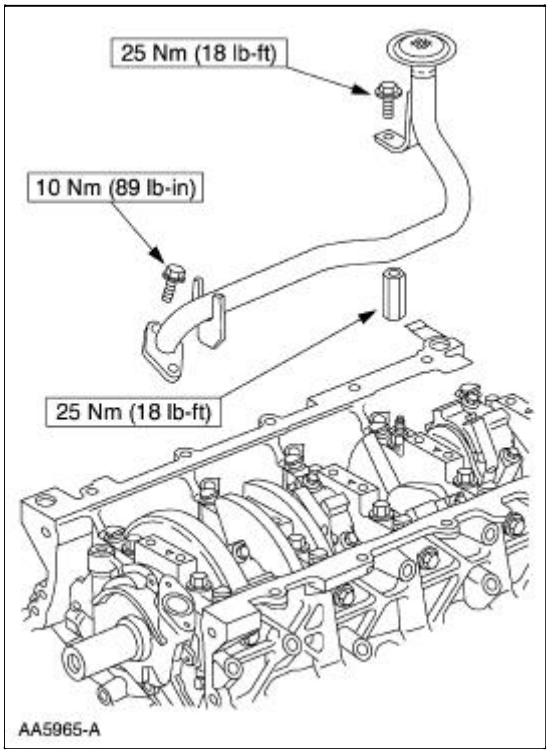
23. Check the connecting rod bearing clearance. For additional information, refer to Section 303-00 .

24. Install the oil pump and tighten the bolts.



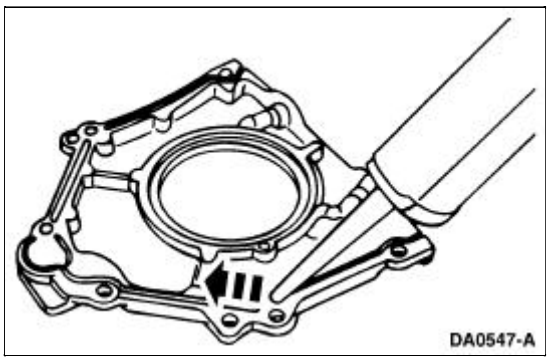
25. **NOTE:** Install a new O-ring if necessary.

Install the oil pump screen cover and tube.



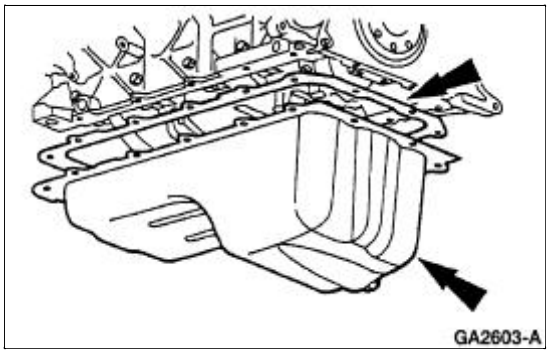
26. **NOTE:** If not secured within four minutes, sealant must be removed and sealing area cleaned with metal surface cleaner. Allow to dry until there are no signs of wetness, or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

    If the retainer plate was removed, apply a 4 mm (0.16 in) bead of silicone gasket and sealant around the rear oil seal retainer sealing surface.

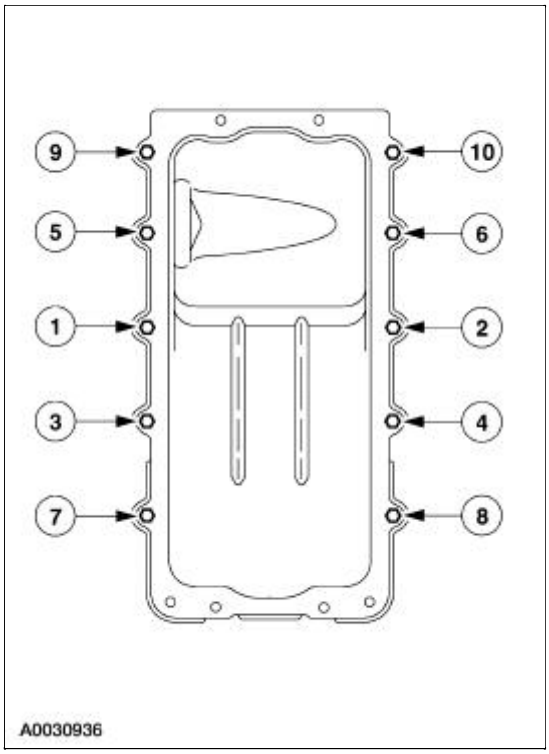


27. Install the rear main seal retainer plate. Tighten the bolts in the sequence shown.
    - Tighten bolts 1-6 to 10 Nm (89 lb-in).
    - Hand-tighten bolts 7 and 8.
    - Tighten bolts 7 and 8 to 20 Nm (15 lb-ft).
    - Tighten bolts 7 and 8 an additional 60 degrees.

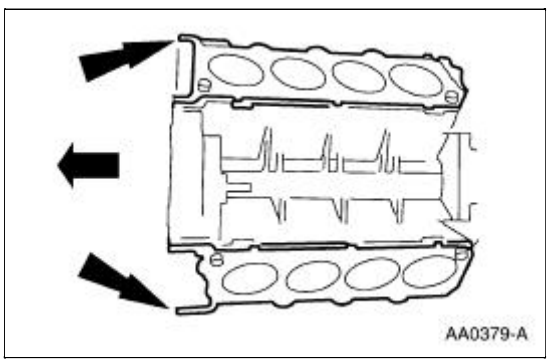
28. Install the oil pan and gasket and loosely install the bolts.



29. Tighten the bolts in the sequence shown.
    - Tighten to 20 Nm (15 lb-ft).
    - Rotate an additional 60 degrees.



30. Install the cylinder head gaskets.



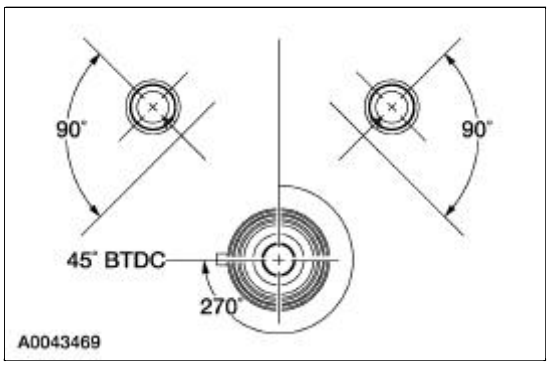
31. **CAUTION: Cylinder head to cylinder block pre-assembly must be followed exactly or damage to valves and pistons can result.**

CAUTION: Camshaft keyways must maintain a 90 degree clocked position relative to the valve cover rail.

CAUTION: To prevent piston crown and valve damage the crankshaft keyway must be clocked at 270° (45° BTDC) before the installation of the cylinder head assembly.

NOTE: Crankshaft must be rotated clockwise only.

Align the keyways as shown.

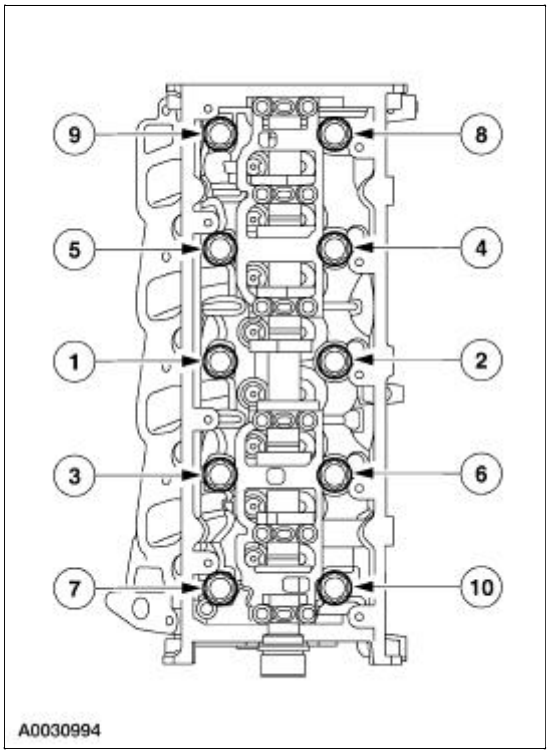


32. **NOTE:** Position the RH and the LH cylinder heads over the dowels on the cylinder head gaskets.

    NOTE: The LH is shown the RH is similar.

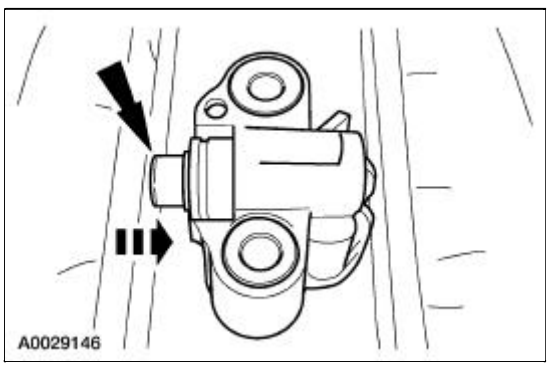
    Tighten the bolts in six stages in the sequence shown.

    - Stage 1: Tighten to 40 Nm (30 lb-ft).
    - Stage 2: Tighten an additional 90 degrees.
    - Stage 3: Loosen the bolts a minimum of one full turn.
    - Stage 4: Tighten to 40 Nm (30 lb-ft).
    - Stage 5: Tighten an additional 90 degrees.
    - Stage 6: Tighten an additional 90 degrees.

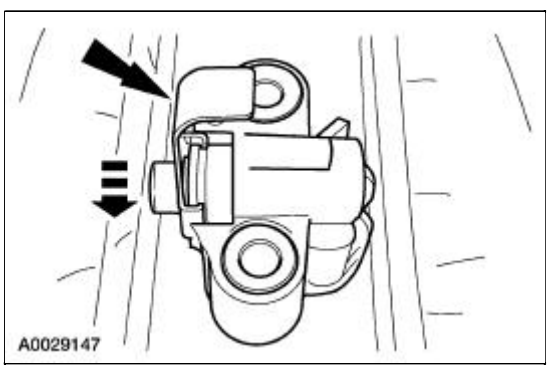


33. **CAUTION: Timing chain procedures must be followed exactly or damage to valves and pistons will result.**

    Using a vise, compress the tensioner plunger.



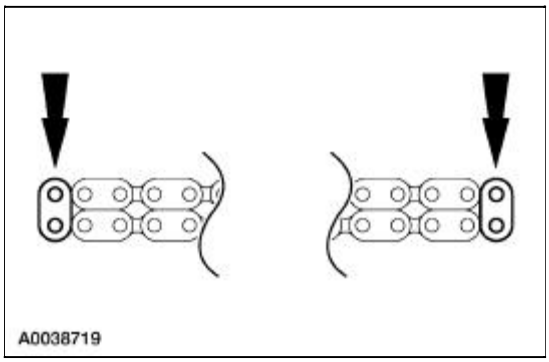
34. Install a retaining clip on the tensioner to hold the plunger in during installation.



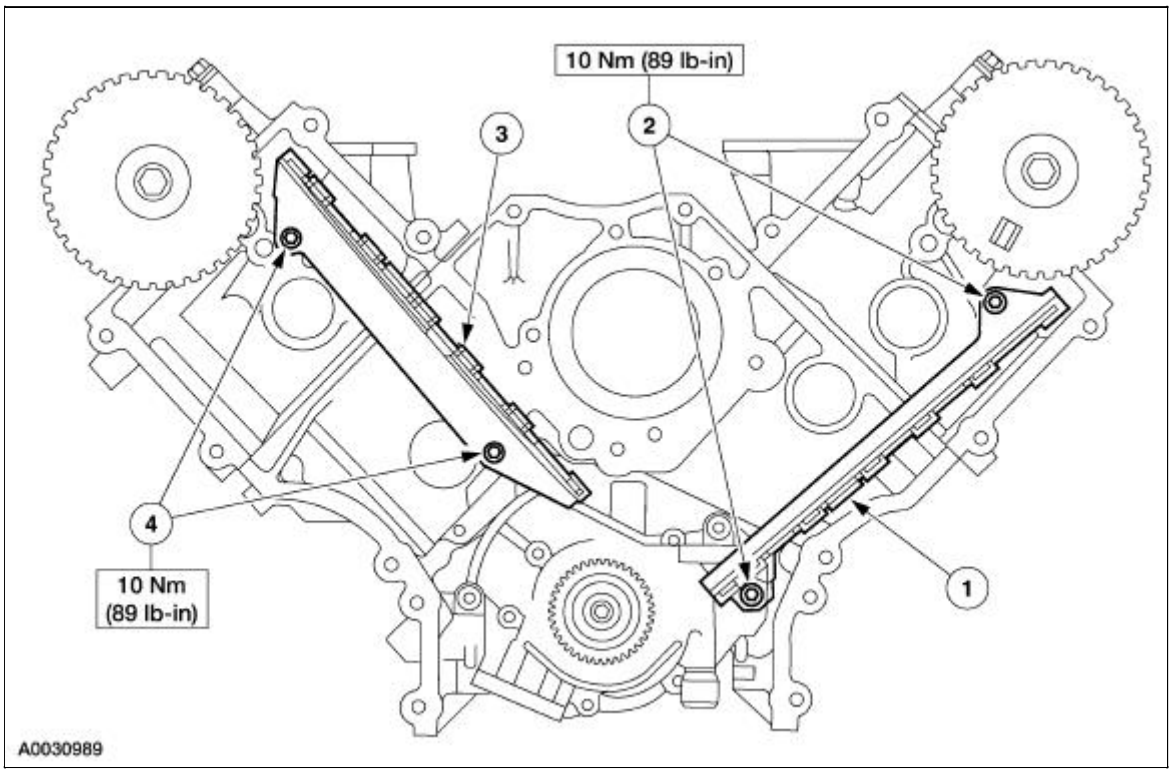
35. Remove the tensioner from the vise.

36. **NOTE:** There are 58 links in each timing chain.

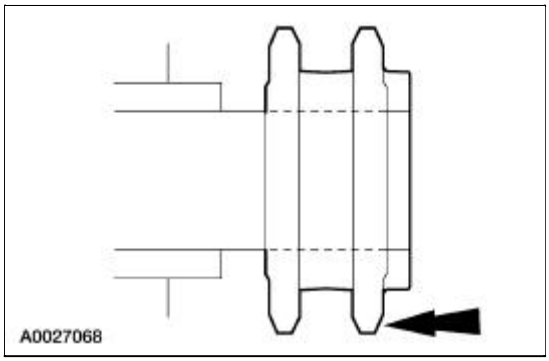
    If the copper links are not visible, mark one link on one end and one link on the other end to use as timing marks.



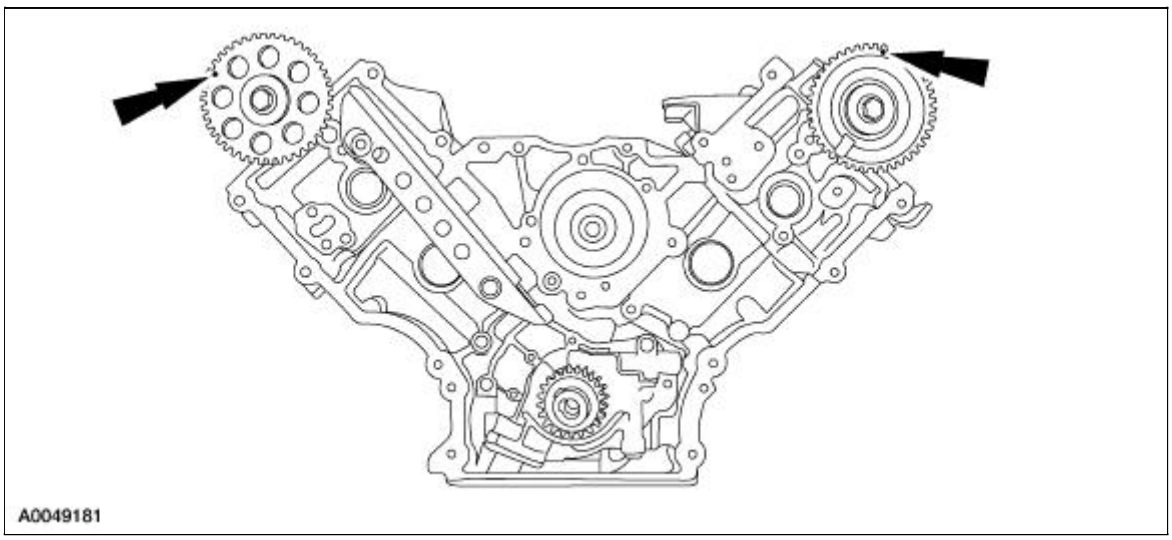
37. Install the timing chain guides.
    1. Position the LH timing chain guide.
    2. Install and tighten the LH bolts.
    3. Position the RH timing chain guide.
    4. Install and tighten the RH bolts.



38. Install the crankshaft sprocket, making sure the flange faces forward.



39. Rotate the RH camshaft sprocket until the timing mark is approximately at the 11 o'clock position. Rotate the LH camshaft sprocket until the timing mark is approximately at the 12 o'clock position.

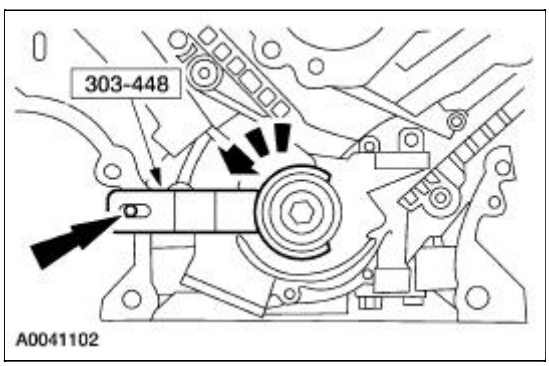


40. **CAUTION: Unless otherwise instructed, do not rotate either the crankshaft or the camshafts, when the timing chains are removed and the cylinder heads are installed. Severe piston and valve damage will occur.**

CAUTION: When instructed to do so, rotate the crankshaft counterclockwise only. Do not rotate past the position shown or severe piston and valve damage can occur.

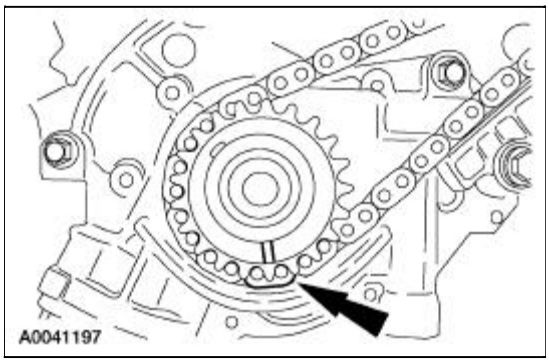
NOTE: The number one cylinder is at top dead center (TDC) when the stud on the engine block fits into the slot in the handle of the special tool.

Using the special tool, position the crankshaft so the number one cylinder is at TDC.

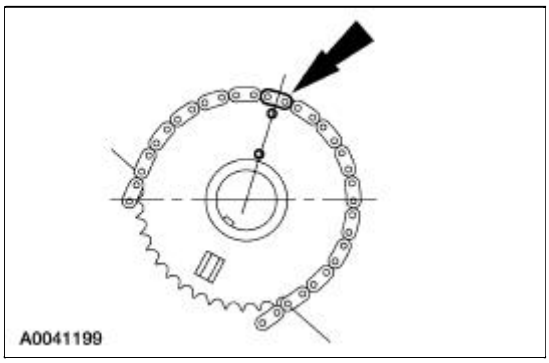


41. Remove the special tool.

42. Position the LH (inner) timing chain on the crankshaft sprocket, aligning the copper (marked) link with the timing mark on the sprocket.

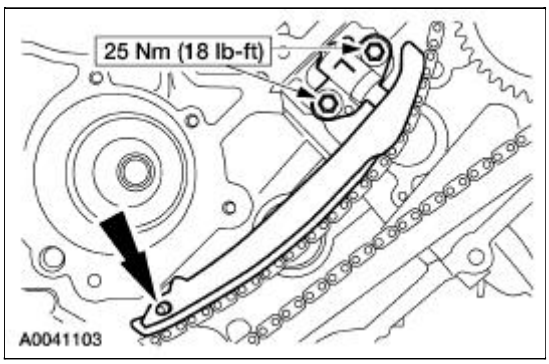


43. Install the LH timing chain on the camshaft sprocket, aligning the copper (marked) link with the timing marks on the sprocket.

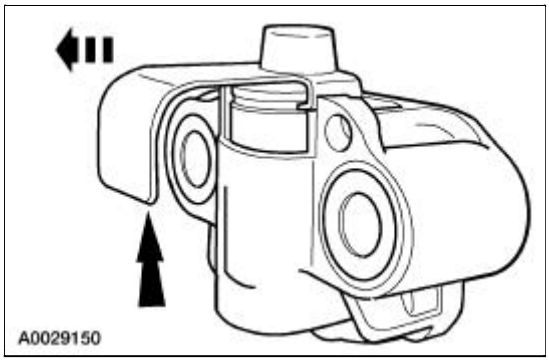


44. **NOTE:** The LH timing chain tensioner arm has a bump near the dowel hole for identification.

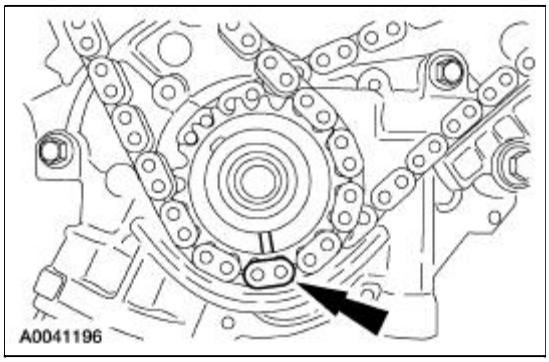
    Position the LH timing chain tensioner arm on the dowel pin and install the LH timing chain tensioner.



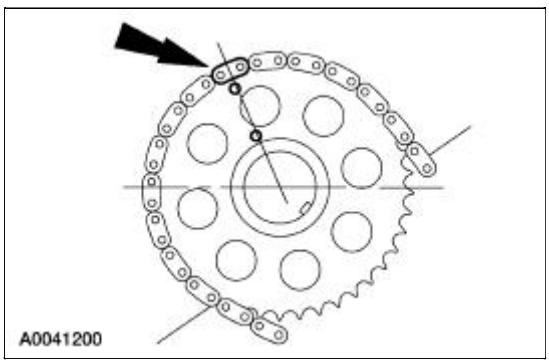
45. Remove the retaining clip from the LH timing chain tensioner.



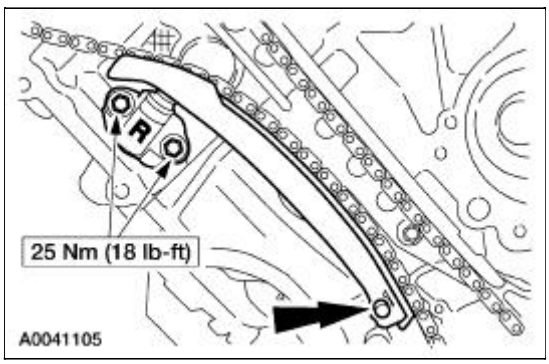
46. Position the RH (outer) timing chain on the crankshaft sprocket, aligning the copper (marked) link with the timing mark on the sprocket.



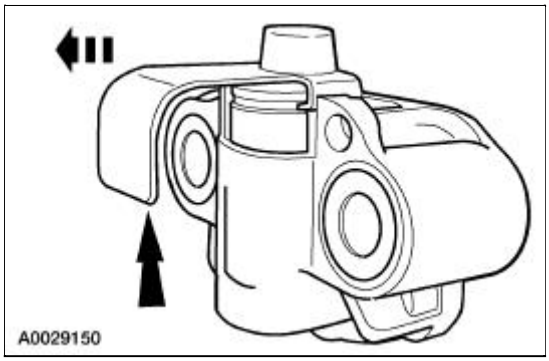
47. Install the RH timing chain on the camshaft sprocket, aligning the copper (marked) link with the timing marks on the sprocket.



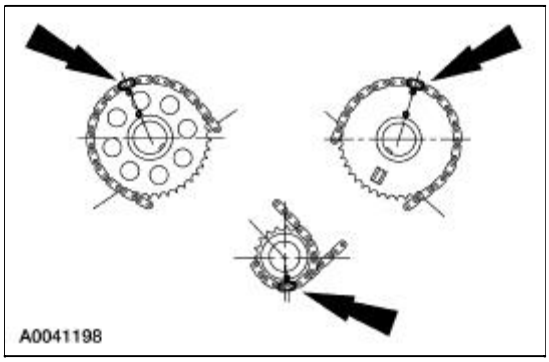
48. Position the RH timing chain tensioner arm on the dowel pin and install the RH timing chain tensioner.



49. Remove the retaining clip from the RH timing chain tensioner.

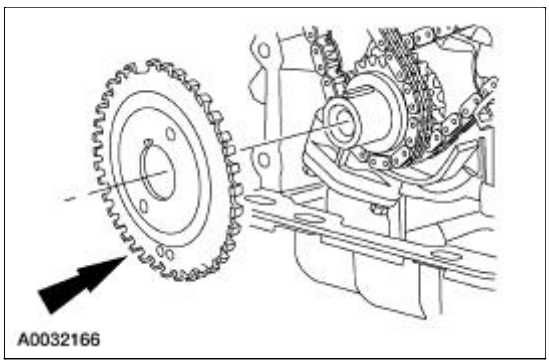


50. Make sure that the copper (marked) chain links are lined up with the dots on the crankshaft sprockets and the camshaft sprocket.



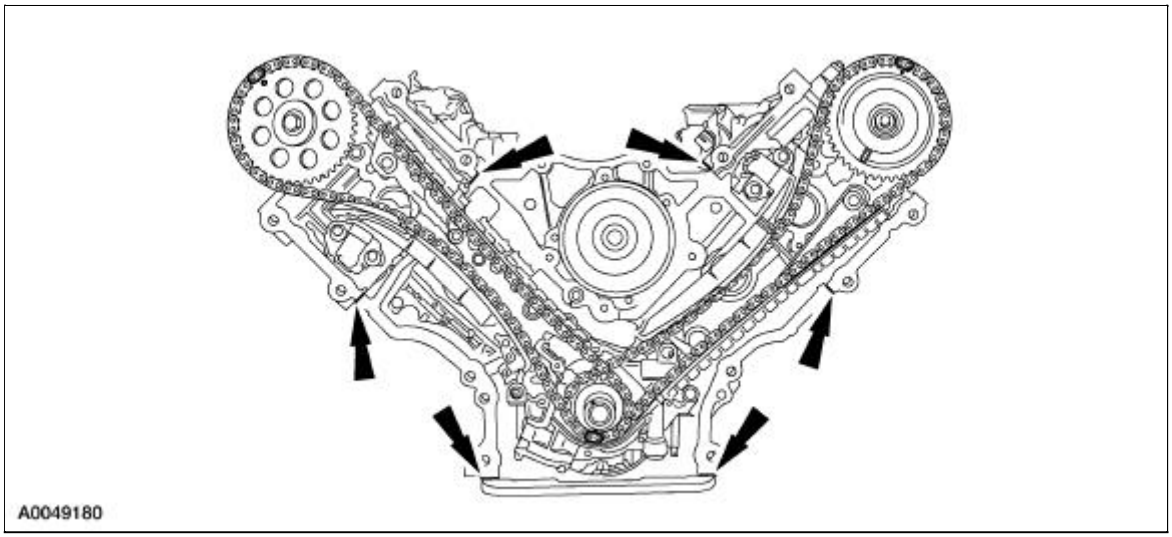
51. **NOTE:** Sensor ring teeth must face forward.

    Position the crankshaft sensor ring on the crankshaft.



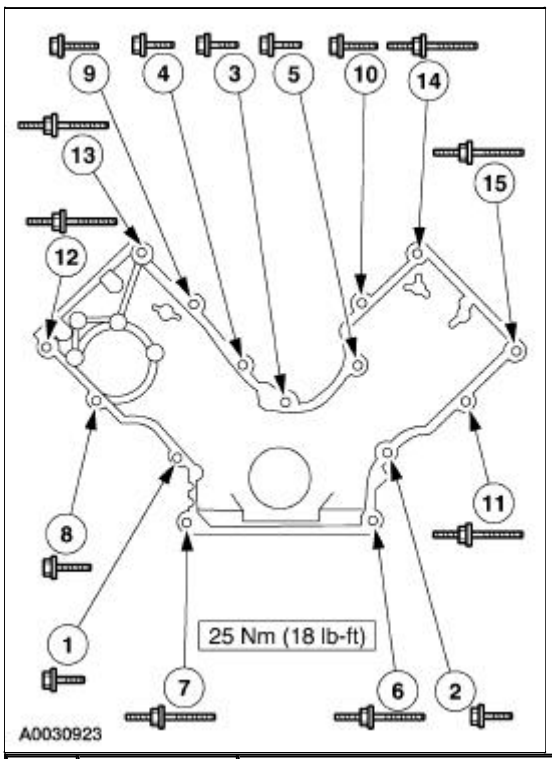
52. **NOTE:** The front cover must be installed within four minutes of applying sealant.

    Apply silicone gasket and sealant in the locations shown.



53. Install a new engine front cover gasket on the engine front cover.

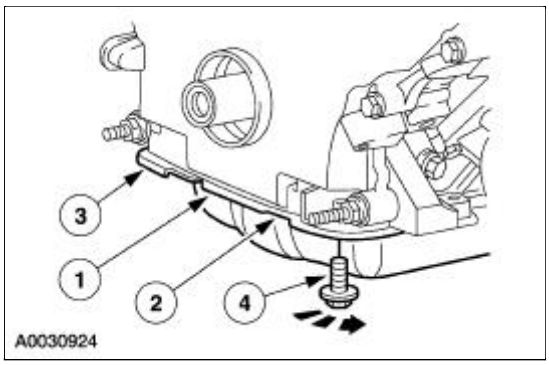
54. Install the engine front cover.



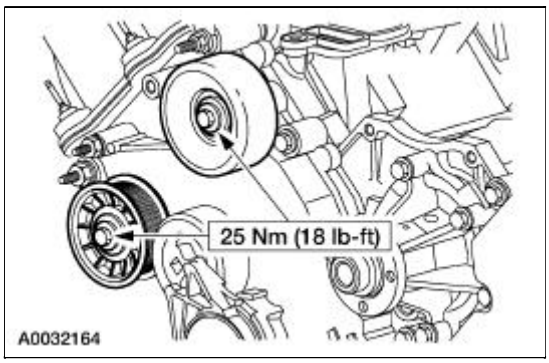
Item	Part Number	Description
1	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
2	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
3	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
4	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
5	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
6	W706508	Stud, Hex Shldr Pilot, M8 x 1.25 x 50 — M6 x 1 x 10
7	N808586	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 60 — M6 x 1 x 26

8	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
9	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
10	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
11	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26
12	W706560	Stud and Washer, Hex-Head Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 16
13	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26
14	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26
15	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26

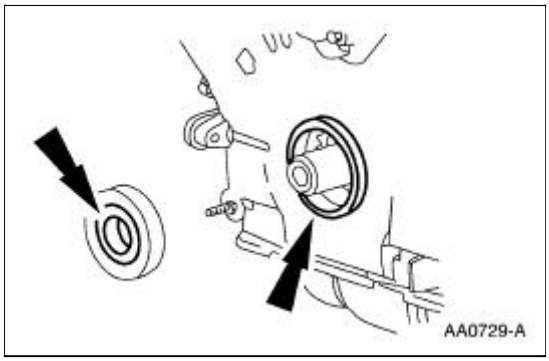
55. Tighten the four oil pan bolts in the sequence shown in three stages.
    - Stage 1: Tighten to 2 Nm (18 lb-in).
    - Stage 2: Tighten to 20 Nm (15 lb-ft).
    - Stage 3: Tighten an additional 60 degrees.



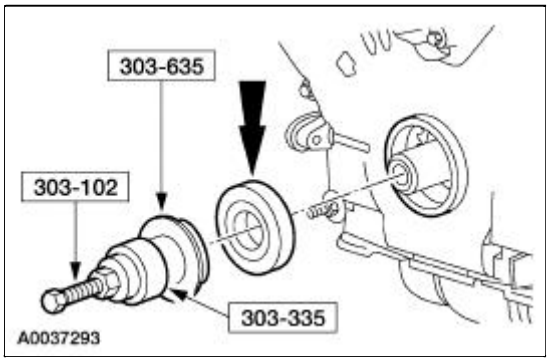
56. Install the belt idler pulleys.



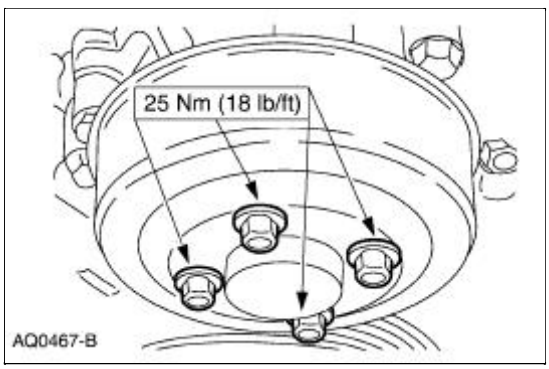
57. Lubricate the engine front cover and the front oil seal inner lip with clean engine oil.



58. Using the special tool, install the front oil seal.

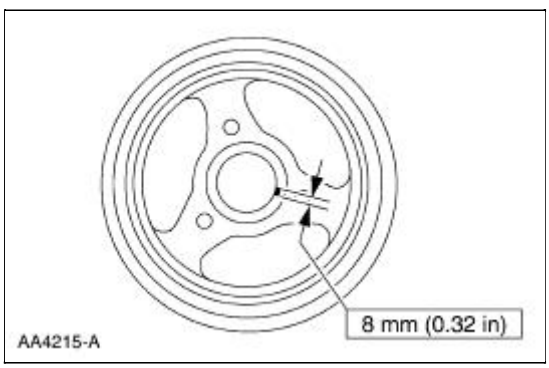


59. Install the water pump pulley and bolts.

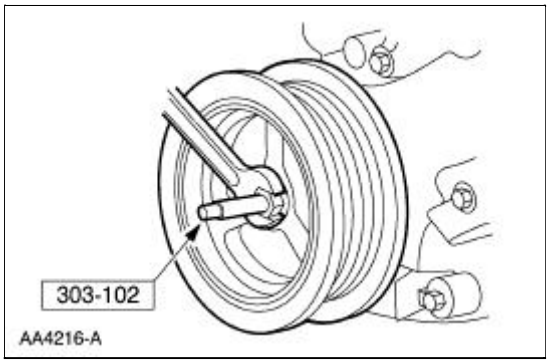


60. **NOTE:** The crankshaft pulley must be installed within four minutes of applying sealant.

    Apply silicone gasket and sealant to the Woodruff key slot on the crankshaft pulley.

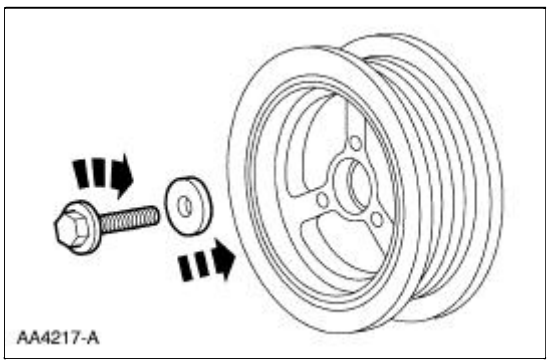


61. Using the special tool, install the crankshaft pulley.

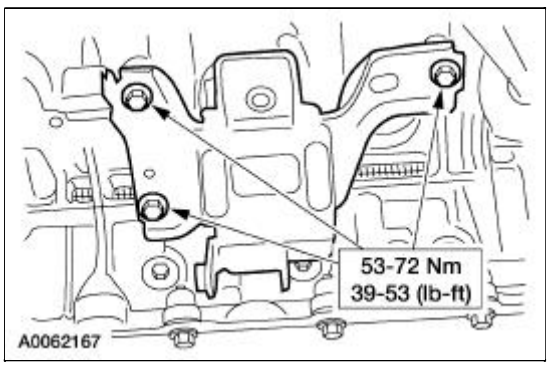


62. **NOTE:** Use special tool 303-009 or a suitable strap wrench to hold the crankshaft pulley.

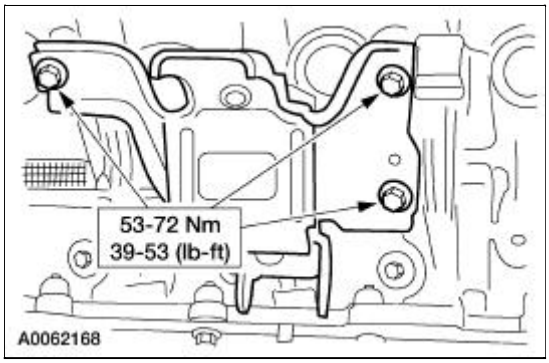
    Install the washer and the bolt. Tighten the bolt in four stages.
    - Stage 1: Tighten to 90 Nm (66 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten to 50 Nm (37 lb-ft).
    - Stage 4: Tighten an additional 90 degrees.



63. Install the LH engine mount.

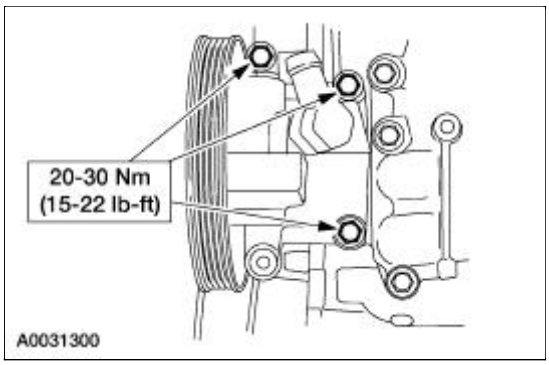


64. Install the RH engine mount.

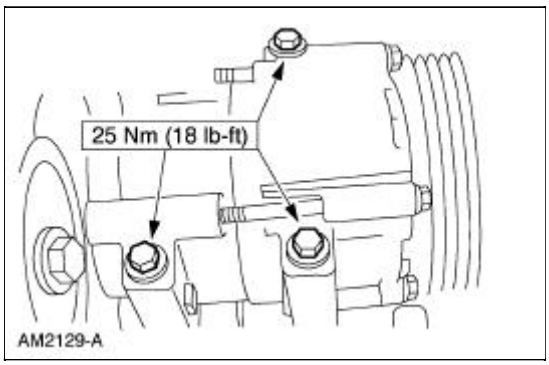


65. **NOTE:** Only three bolts are required for installation.

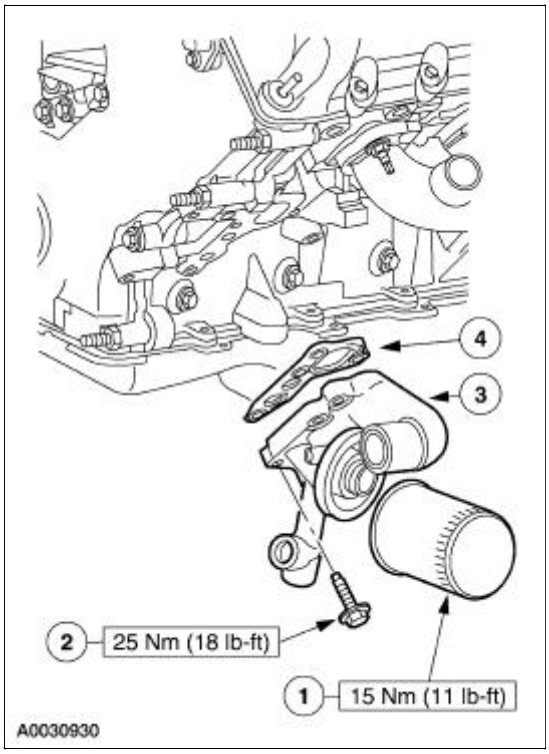
    Install the power steering pump.
    - Position the power steering pump.
    - Install the bolts.



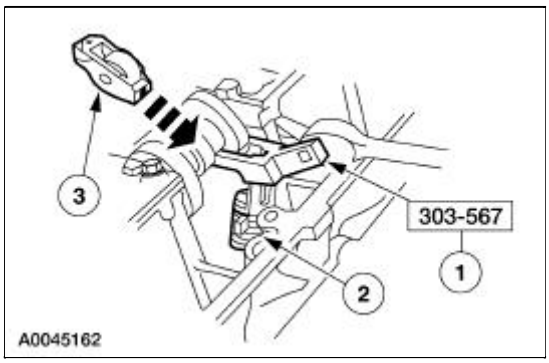
66. Lubricate the O-ring seal with PAG compressor oil, YN-12C, F7AZ-19589-DA or equivalent meeting Ford specification WSH-M1C231-B.
    Install the A/C compressor.



67. Install the oil filter adapter.

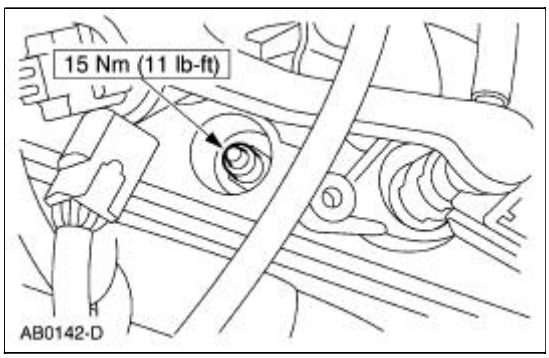


68. Install the camshaft roller followers.
    1. Install the special tool.
    2. Compress the valve spring.
    3. Install the camshaft follower.



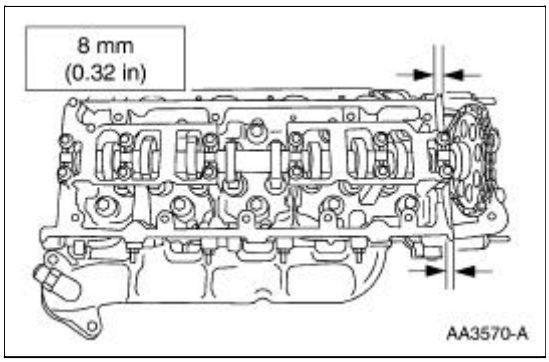
69. **NOTE:** One spark plug shown, others similar.

    Install spark plugs.



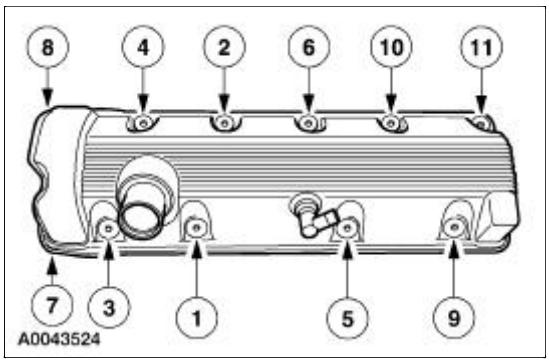
70. **NOTE:** The RH side is shown, the LH side is similar.

Apply an eight millimeter bead of silicone gasket and sealant at the intersection of the engine front cover and the cylinder head.



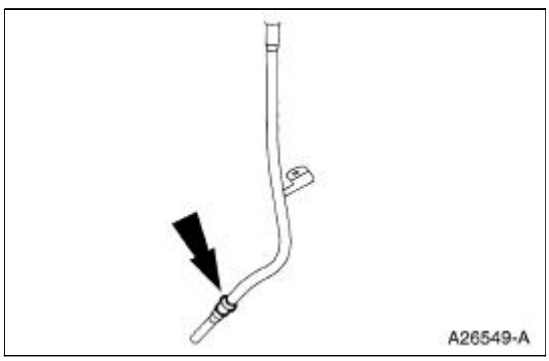
71. **NOTE:** RH valve cover shown, LH similar.

    Install the valve covers.

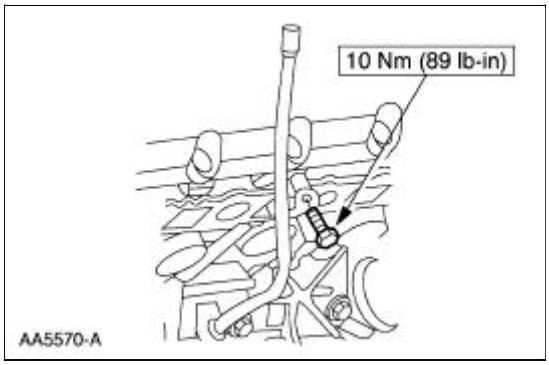


72. **NOTE:** Lubricate the O-ring seal with clean engine oil.

    Install a new O-ring.

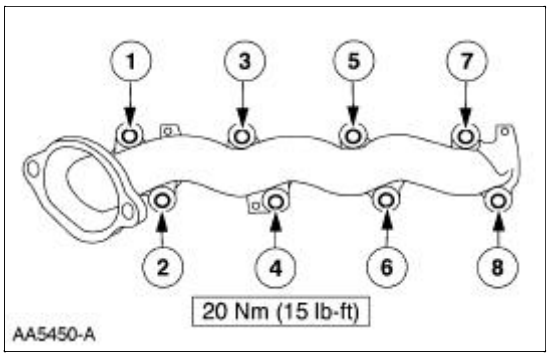


73. Install the tube.

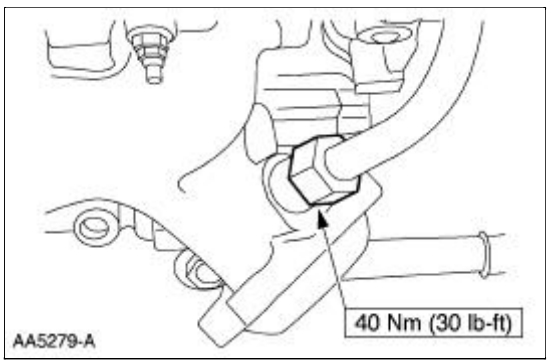


74. **NOTE:** RH exhaust manifold shown, LH similar. Tighten the bolts in the sequence shown.

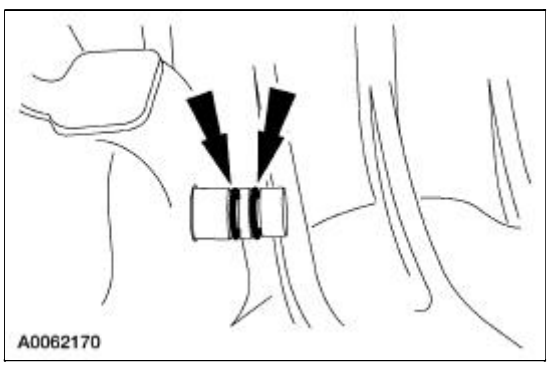
    Install the LH exhaust manifold.



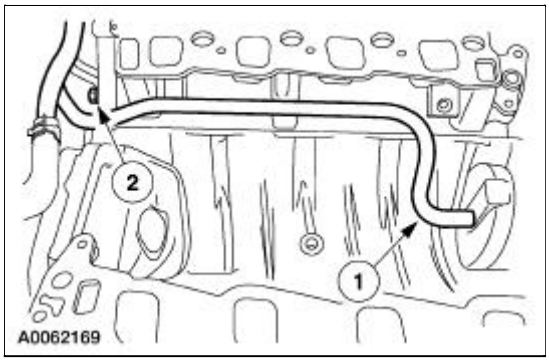
75. Connect the lower end of the EGR tube to the LH exhaust manifold.



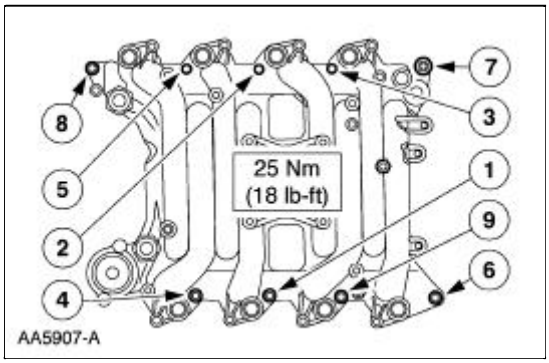
76. Inspect the O-ring seals and install new O-ring seals as necessary.



77. Install the water bypass tube.
    1. Instal the bypass tube.
    2. Install the nut.



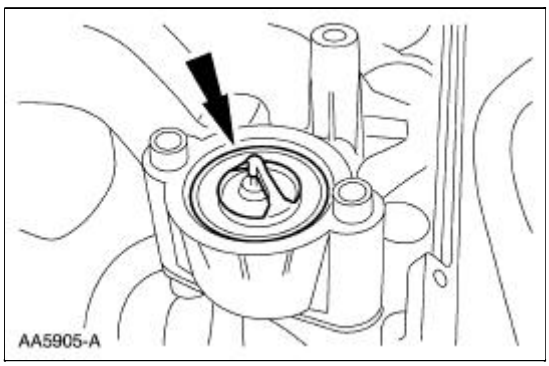
78. Install the intake manifold and gaskets. Tighten the bolts in the sequence shown.



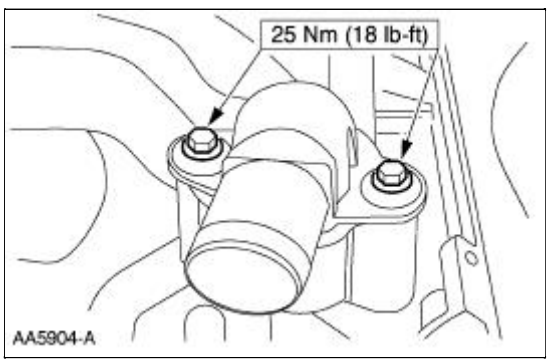
79. **NOTE:** The O-ring is to be installed on top of the thermostat.

    Install the water thermostat and O-ring.

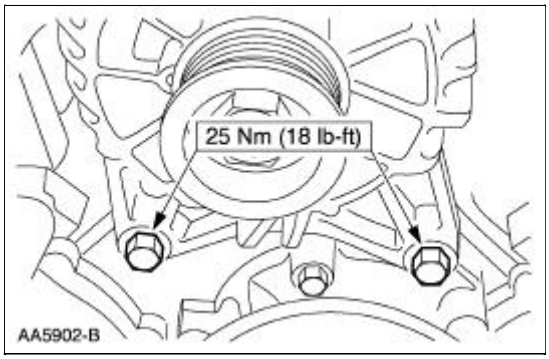
    - Install a new O-ring as necessary.



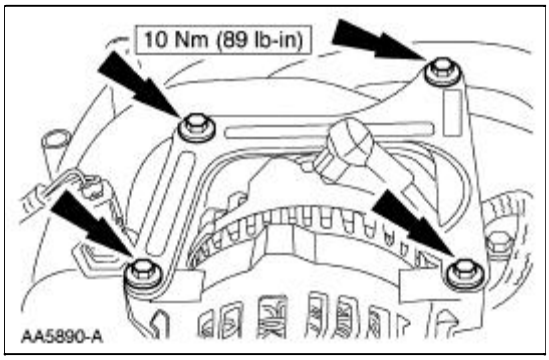
80. Install the water outlet connector.



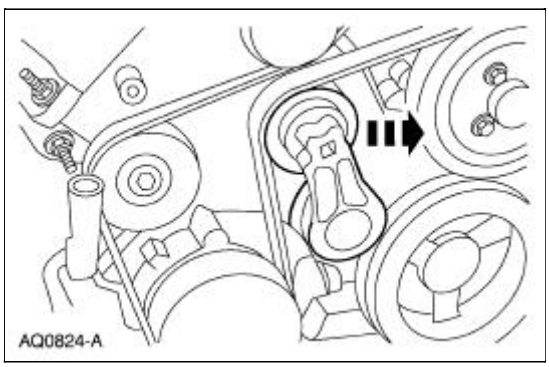
81. Install the bolts and the generator.



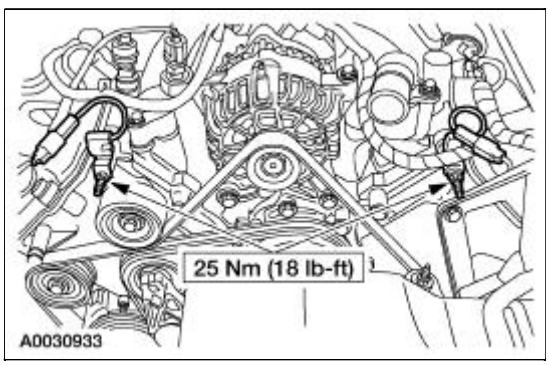
82. Install the generator support brace.



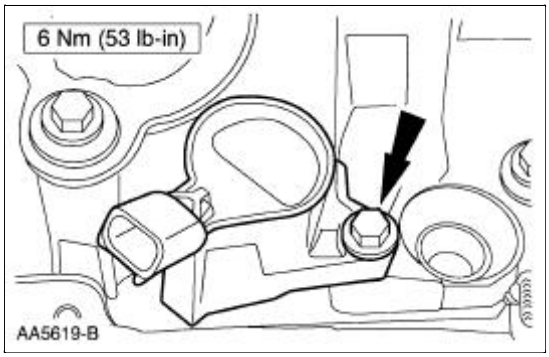
83. Install the accessory drive belt. For additional information, refer to Section 303-05 .



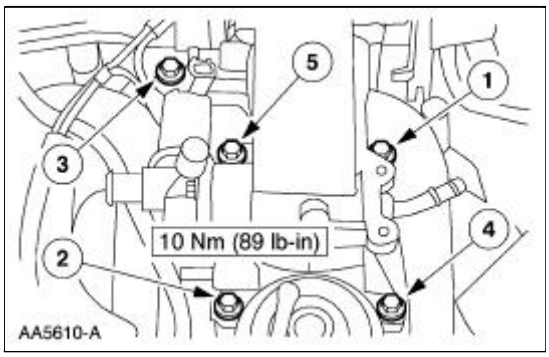
84. Install the radio interference capacitors.



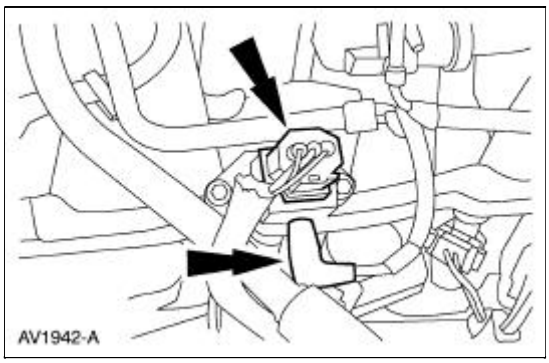
85. Install the ignition coils and bolts.



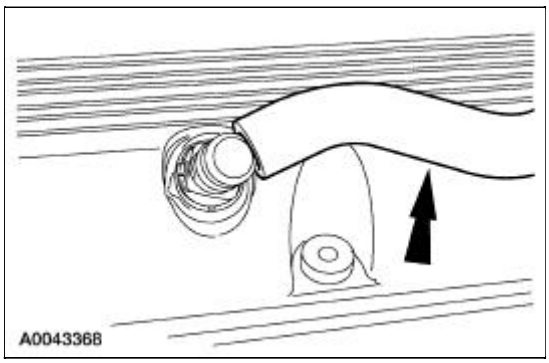
86. Position the throttle body and install the bolts, tighten in the sequence shown.



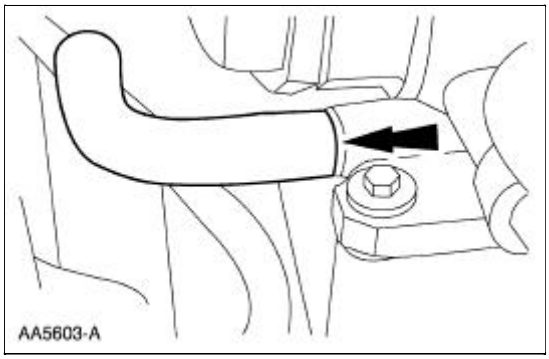
87. Connect the vacuum line to the fuel pressure sensor.



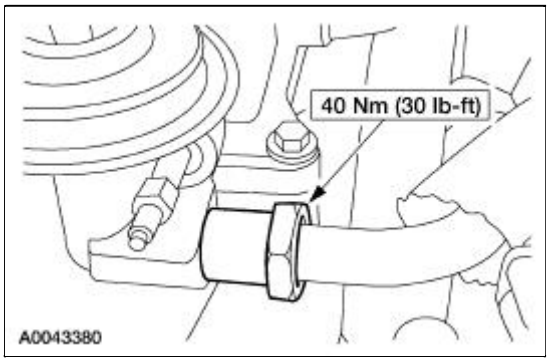
88. Connect the PCV hose.



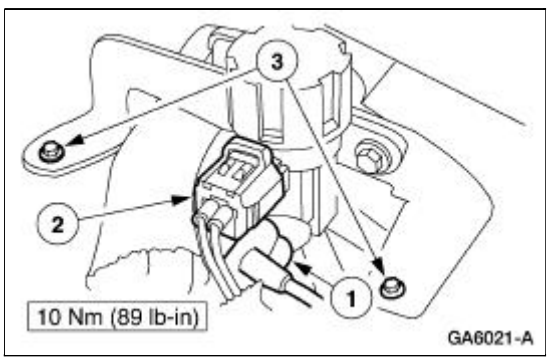
89. Connect the PCV hose to the base of the throttle body.



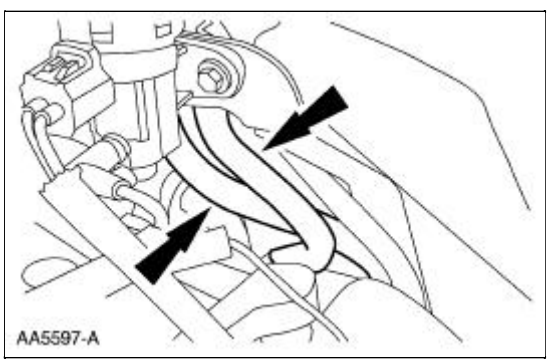
90. Connect the EGR tube to the EGR valve.



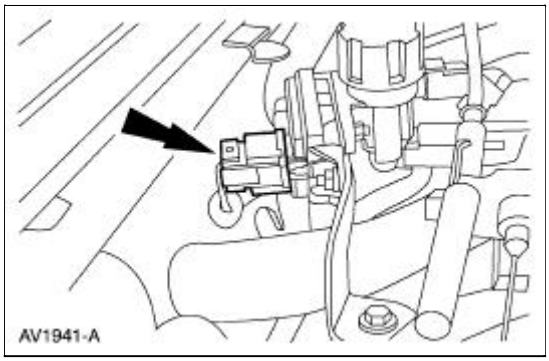
91. Install the EGR vacuum regulator solenoid.
    1. Install the vacuum hoses.
    2. Install the electrical connector.
    3. Install the bolts.



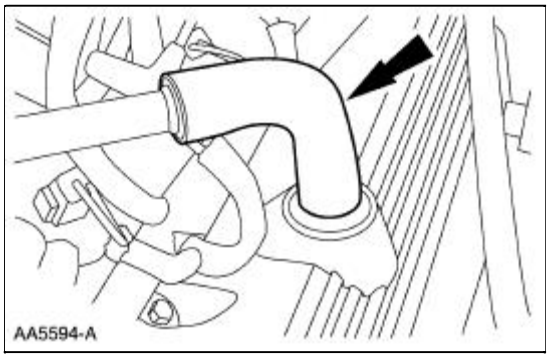
92. Connect the hoses from the differential pressure feedback EGR transducer.



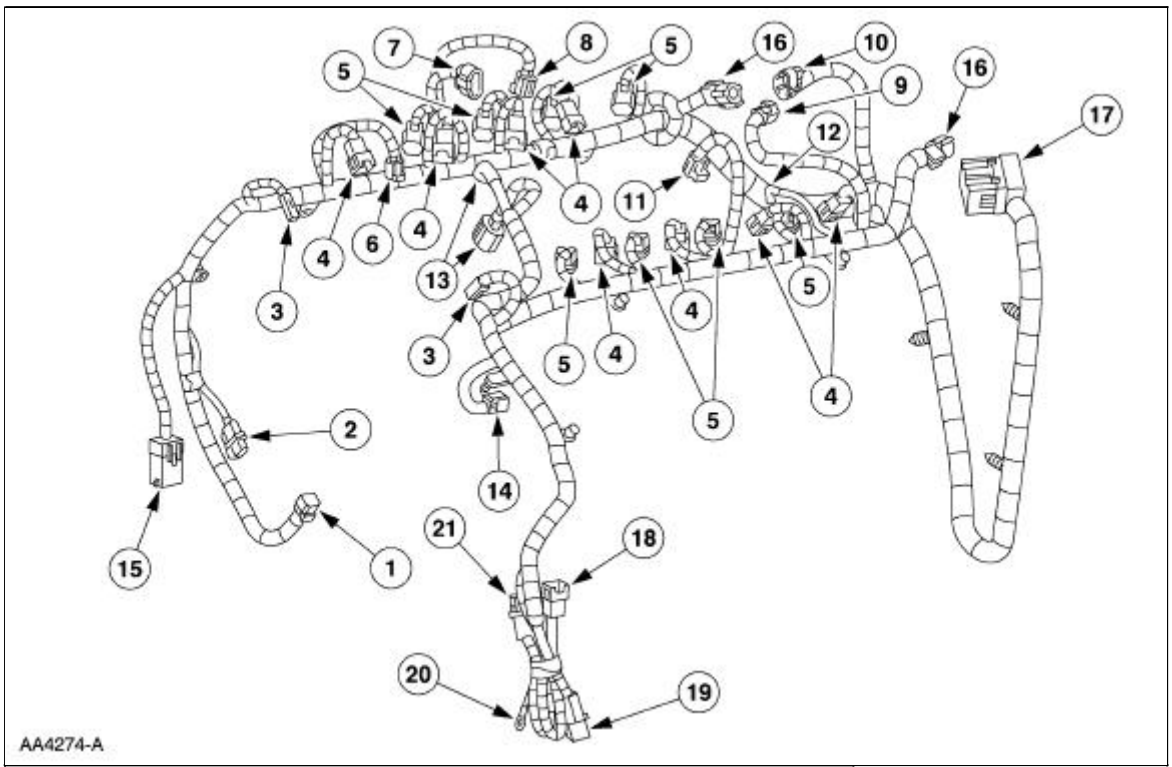
93. Connect the differential pressure feedback EGR electrical connector.



94. Install the breather tube.



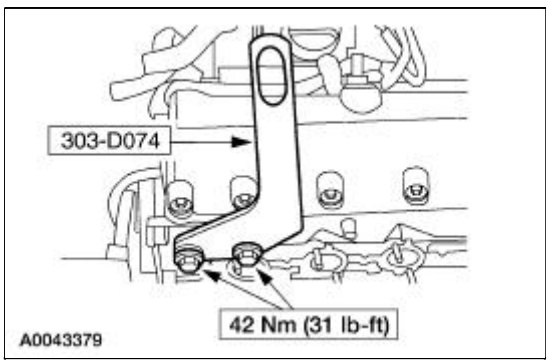
95. Install the engine control sensor wiring.



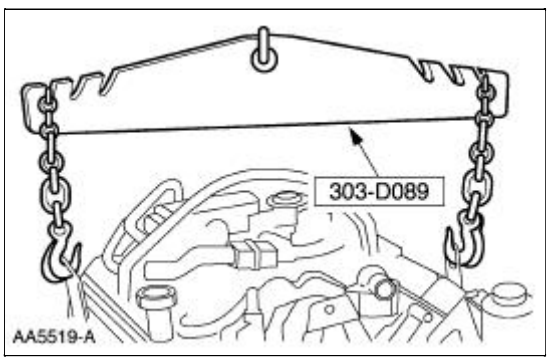
Item	Part Number	Description
1	—	To crankshaft position sensor
2	—	To A/C compressor
3	—	To radio ignition interference capacitor (2)
4	—	To fuel injectors (8)

5	—	To ignition coils (8)
6	—	To engine coolant temperature sensor
7	—	To throttle position sensor
8	—	To idle air control valve
9	—	To EGR vacuum regulator
10	—	To differential pressure feedback EGR
11	—	To fuel pressure regulator
12	—	Fuel injection ground
13	—	To generator
14	—	To camshaft position sensor
15	—	To body
16	—	To heated oxygen sensor (2)
17	—	Engine bulkhead connector
18	—	To low coolant sensor
19	—	To body
20	—	To power distribution box
21	—	To body

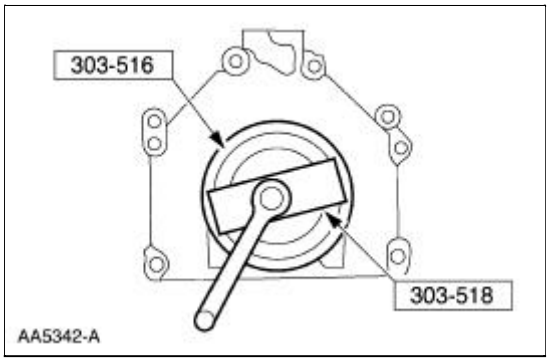
96. Install the RH and LH special tools.



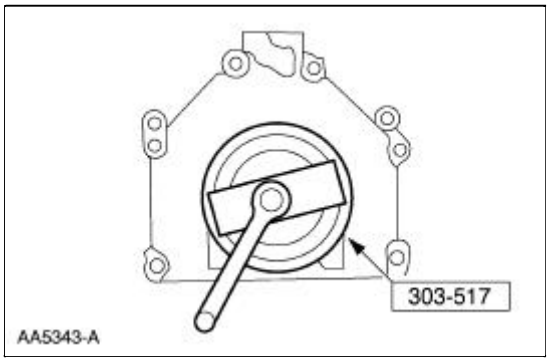
97. Using the special tool, remove the engine from the stand.



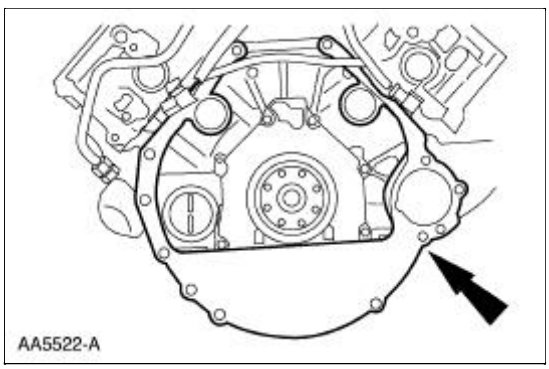
98. Using the special tool, install the crankshaft rear main seal.
    - Lubricate the oil seal using clean engine oil.



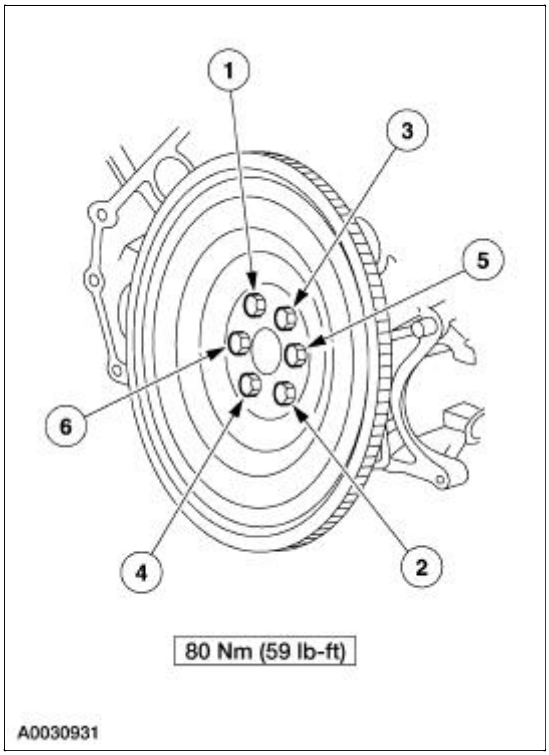
99. Using the special tools, install the crankshaft rear oil slinger.



100. Install the separator plate.

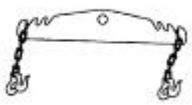
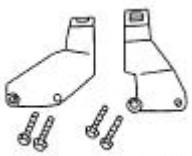


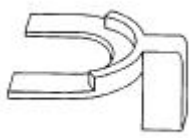
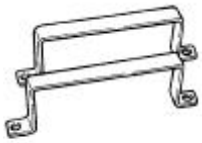
101. Install the flywheel.


1
3
5
6
4
2
80 Nm (59 lb-ft)
A0030931

Cylinder Heads

Special Tool(s)

ST1287-A	Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)
ST1328-A	Installer, Front Cover Oil Seal 303-335 (T88T-6701-A)
ST1335-A	Holding Tool, Crankshaft 303-448 (T93P-6303-A)
 ST1602-A	Spreader Bar 303-D089 (D93P-6001-A3)
 ST1701-A	Lifting Bracket Set, Engine 303-D074 (D91P-6001-A)
ST1438-A	Strap Wrench 303-D055 (D85L-6000-A) or equivalent
ST1330-A	Compressor, Valve Spring 303-567 (T97P-6565-AH)
	Compressor Spacer, Valve Spring

 ST1331-A	303-382 (T91P-6565-AH)
 ST1668-A	Remover/Installer, Cylinder Head 303-572 (T97T-6000-A)

Material

Item	Specification
Motorcraft Silicone Gasket Remover ZC-30	—
Motorcraft Metal Surface Prep ZC-31	—
Hydraulic Chain Tensioner Retaining Clip 1L3Z-6P250-AA	—
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4
Super Premium SAE 5W-20 Engine Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Both cylinder heads

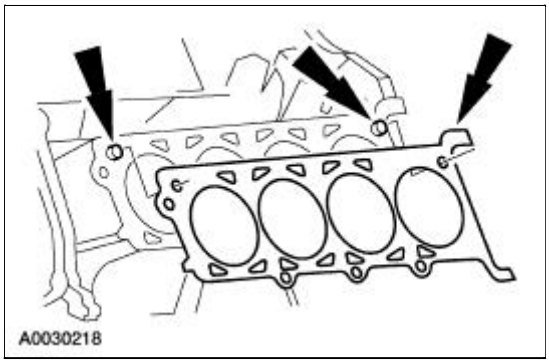
1. **CAUTION: The gasket sealing surfaces on the cylinder head and cylinder block must be clean. For additional information, refer to Cylinder Heads in the Removal portion of this section.**

   CAUTION: The use of sealing aids (aviation cement, copper spray and glue) is not permitted. The gasket must be installed dry.

   CAUTION: The new gasket has a film coating which is crucial to the gasket's ability to seal correctly. Do not scratch the gasket.

   NOTE: RH head gasket shown; LH head gasket similar.

   Install the head gasket over the dowel pins.



2. **CAUTION: Cylinder head machining or milling is not authorized by the Ford Motor Company. Cylinder head flatness must be within 0.0254 mm (0.001 in) across a 38.1 mm (1.5 in) square area.**

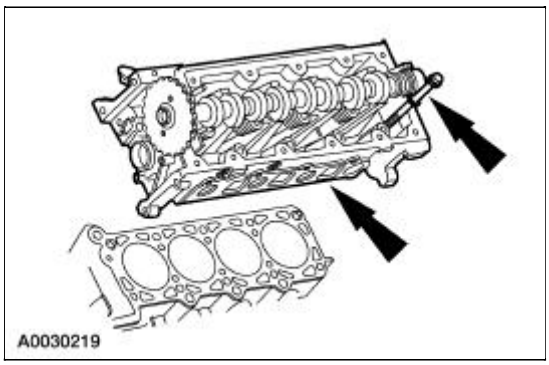
   CAUTION: The use of sealing aids (aviation cement, copper spray and glue) is not permitted. The gasket must be installed dry.

   CAUTION: Do not allow the dowels to scratch the sealing surface of the cylinder head during cylinder head installation.

   NOTE: The new cylinder head bolts must be lightly oiled with a rag, and allowed to drain for a few minutes prior to installation.

   NOTE: RH head gasket shown; LH head gasket similar.

   Install the cylinder head on the dowels and the head gasket. Loosely install new bolts.

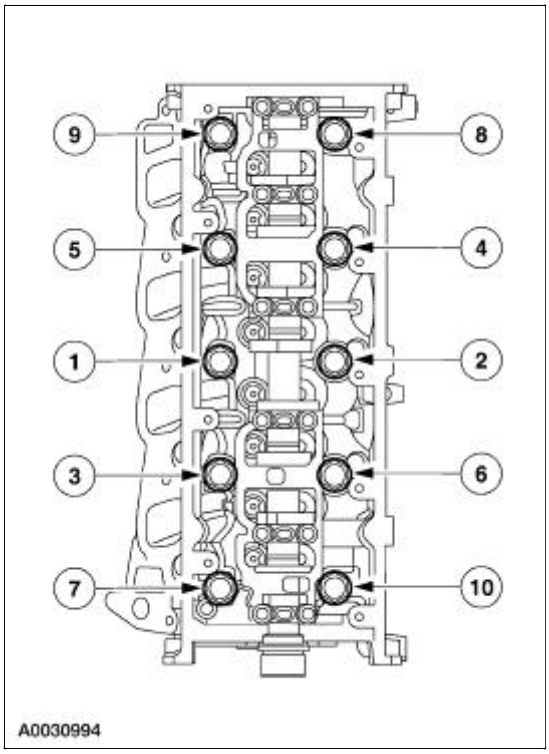


NOTE: Position the cylinder head(s) over the dowels on the head gasket(s).

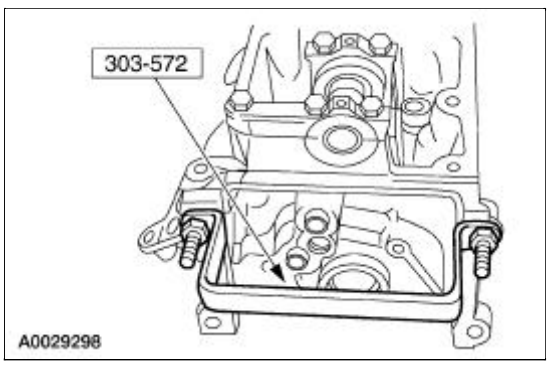
3. **NOTE:** LH shown, RH similar.

   Tighten the bolts in six stages in the sequence shown.

   - Stage 1: Tighten to 40 Nm (30 lb-ft).
   - Stage 2: Tighten an additional 90 degrees.
   - Stage 3: Loosen the bolts a minimum of one full turn.
   - Stage 4: Tighten to 40 Nm (30 lb-ft).
   - Stage 5: Tighten an additional 90 degrees.
   - Stage 6: Tighten an additional 90 degrees.

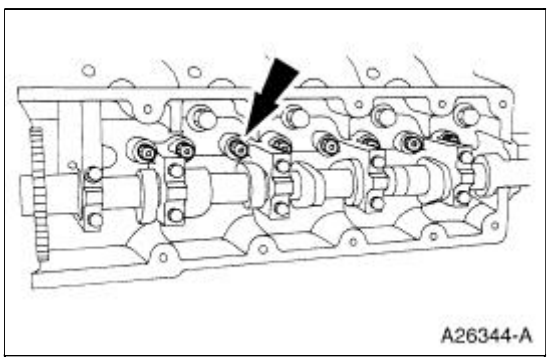


4. Remove the special tools from both ends of the cylinder head.



NOTE: Lubricate the hydraulic lash adjusters with clean engine oil.

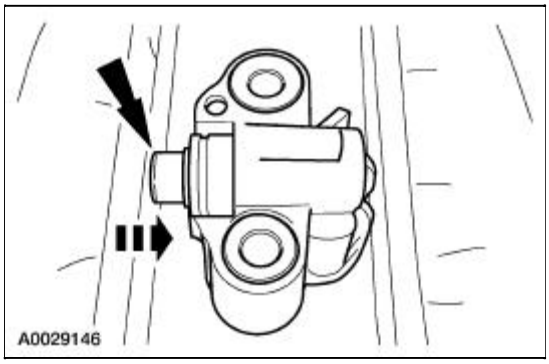
5. Install the hydraulic lash adjusters in their original locations.



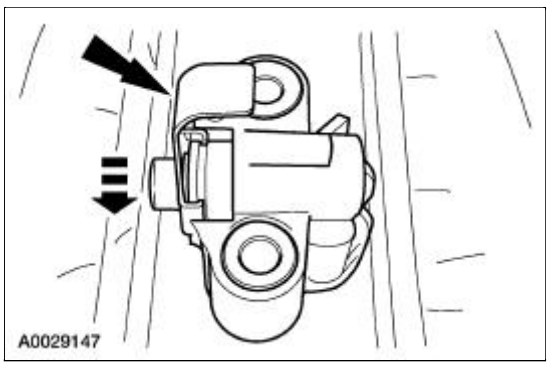
6. **CAUTION: Timing chain procedures must be followed exactly or damage to the valves and pistons will result.**

   NOTE: LH shown, RH similar.

Compress each tensioner plunger, using a vise.

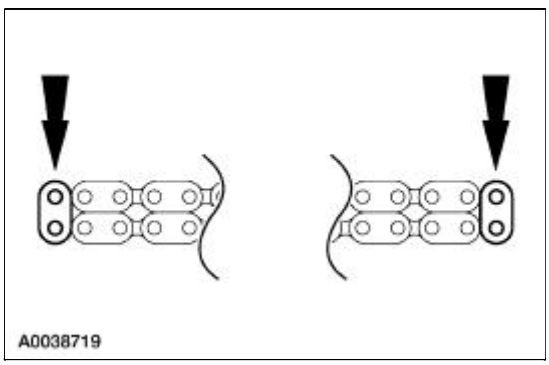


7. Install a retaining clip on each tensioner to hold the plunger in during installation.

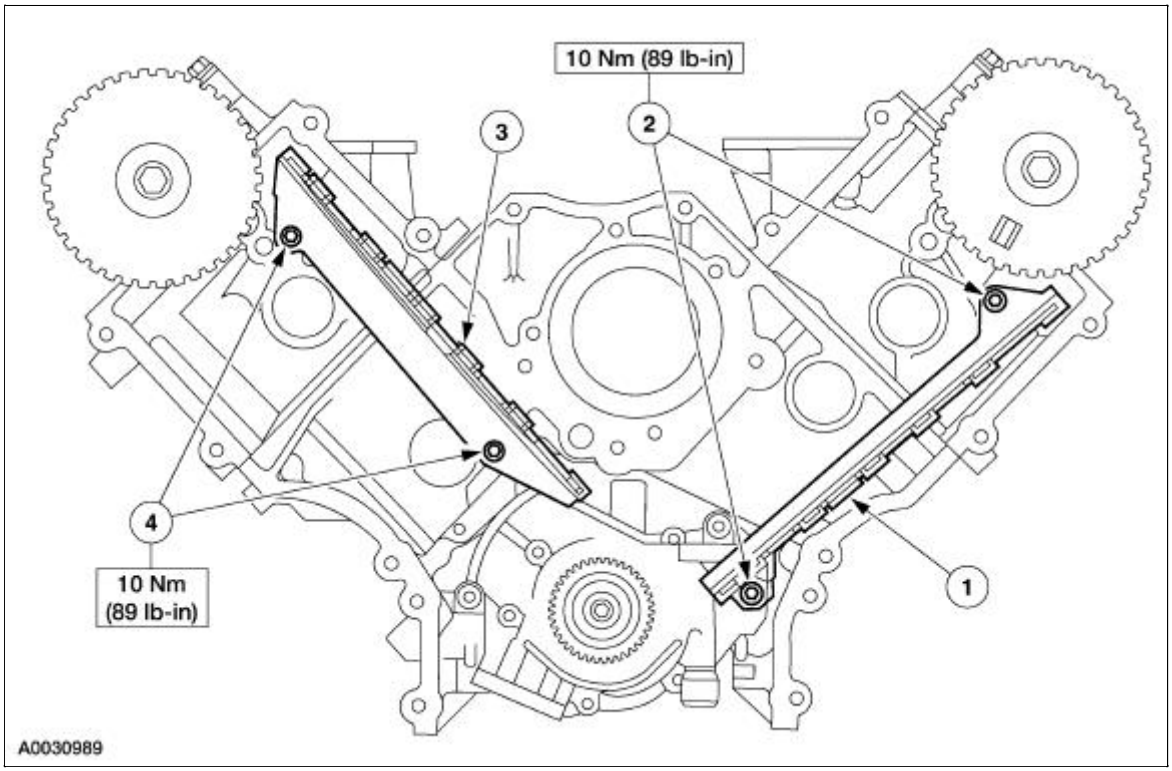


8. Remove the tensioner from the vise.

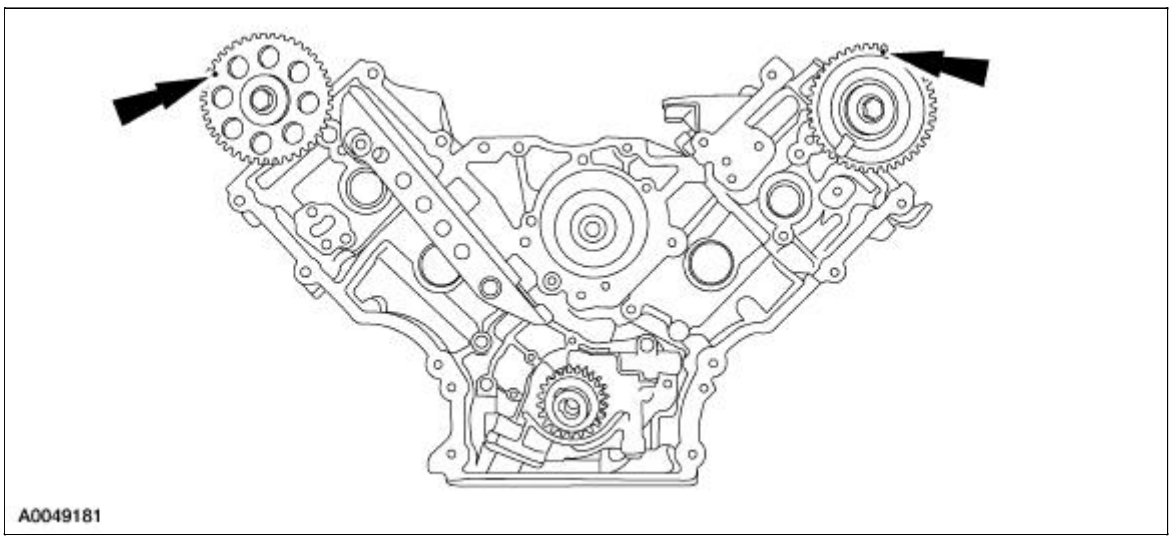
9. If the copper links are not visible, mark one link on one end and one link on the other end, and use as timing marks.



10. Install the timing chain guides.
    1. Position LH timing chain guide.
    2. Install and tighten the bolts.
    3. Position the RH timing chain guide.
    4. Install and tighten the RH bolts.



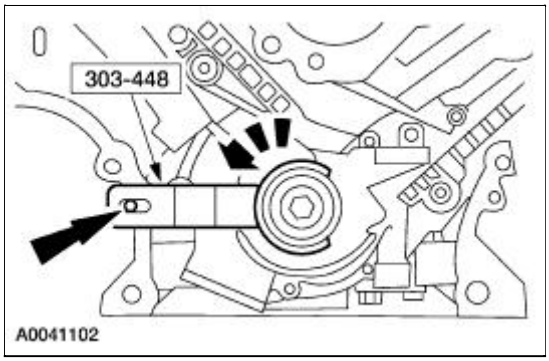
11. Rotate the RH camshaft sprocket until the timing mark is approximately at the 11 o'clock position. Rotate the LH camshaft sprocket until the timing mark is approximately at the 12 o'clock position.



12. **CAUTION: When instructed to do so, rotate the crankshaft counterclockwise only. Do not rotate past the position shown or severe piston and valve damage can occur.**

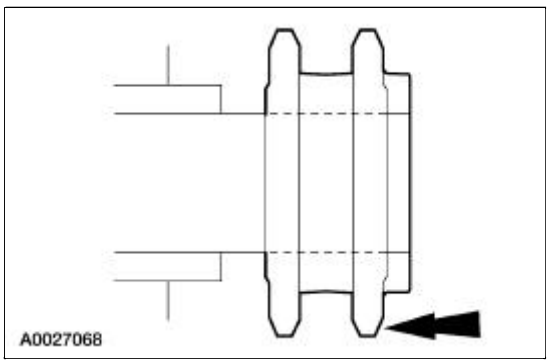
    NOTE: The number one cylinder is at top dead center (TDC) when the stud on the engine block fits into the slot in the handle of the special tool.

    Using the special tool, position the crankshaft so the number one cylinder is at TDC.

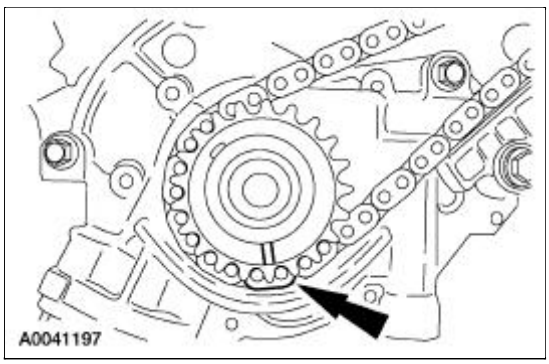


13. Remove the special tool.

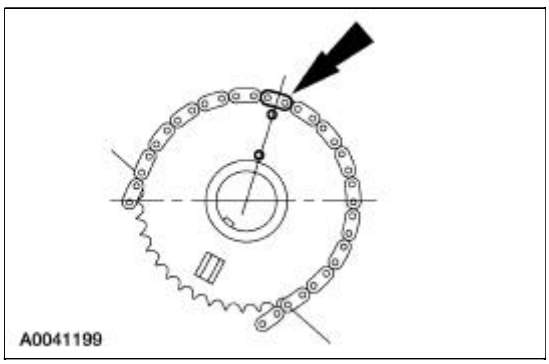
14. Install the crankshaft sprocket, making sure the flange faces forward.



15. Position the LH (inner) timing chain on the crankshaft sprocket, aligning the copper (marked) link with the timing mark on the sprocket.

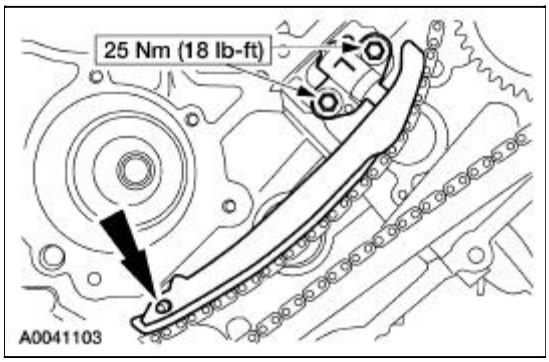


16. Install the LH timing chain on the camshaft sprocket, aligning the copper (marked) link with the timing marks on the sprocket.

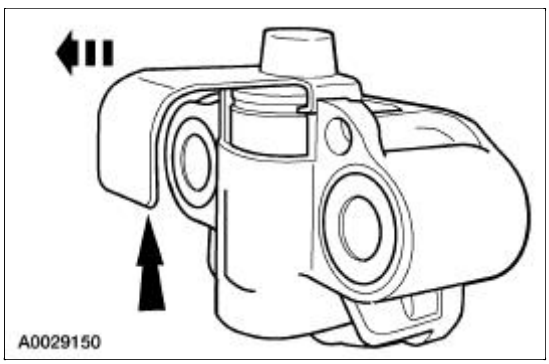


17. **NOTE:** The LH timing chain tensioner arm has a bump near the dowel hole for identification.

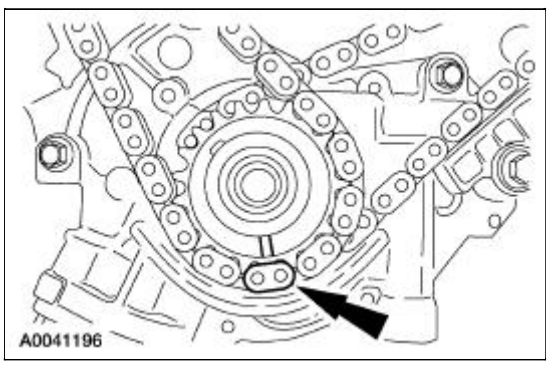
    Position the LH timing chain tensioner arm on the dowel pin and install the LH timing chain tensioner.



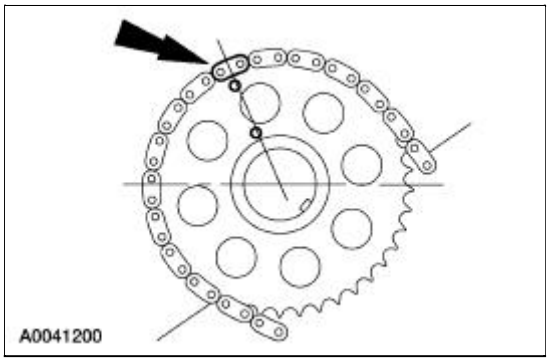
18. Remove the retaining clip from the LH timing chain tensioner.



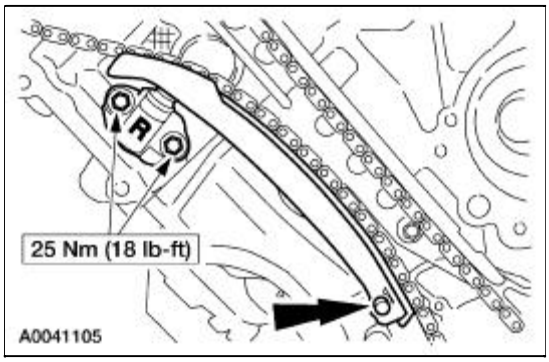
19. Position the RH (outer) timing chain on the crankshaft sprocket, aligning the copper (marked) link with the timing mark on the sprocket.



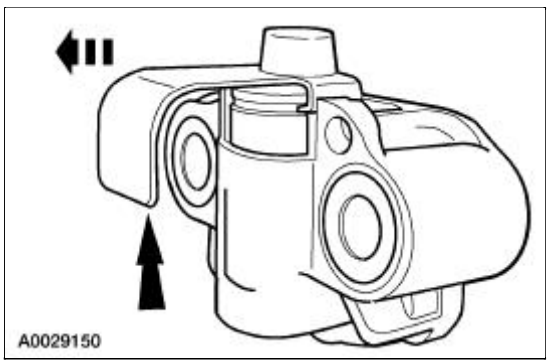
20. Install the RH timing chain on the camshaft sprocket, aligning the copper (marked) link with the timing marks on the sprocket.



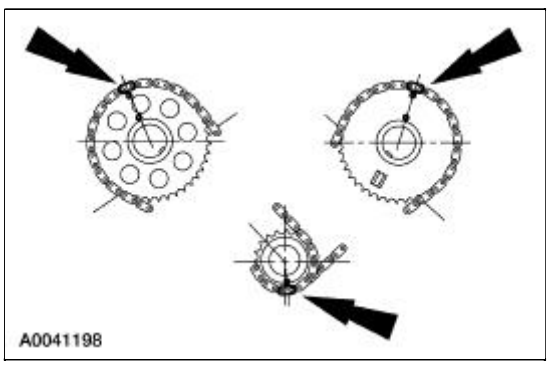
21. Position the RH timing chain tensioner arm on the dowel pin and install the RH timing chain tensioner.



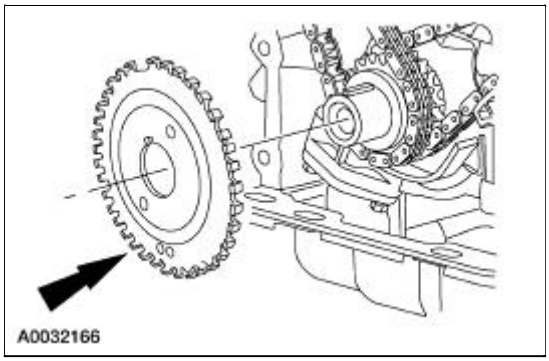
22. Remove the retaining clip from the RH timing chain tensioner.



23. Make sure that the copper (marked) chain links are lined up with the dots on the crankshaft sprockets and the camshaft sprocket.

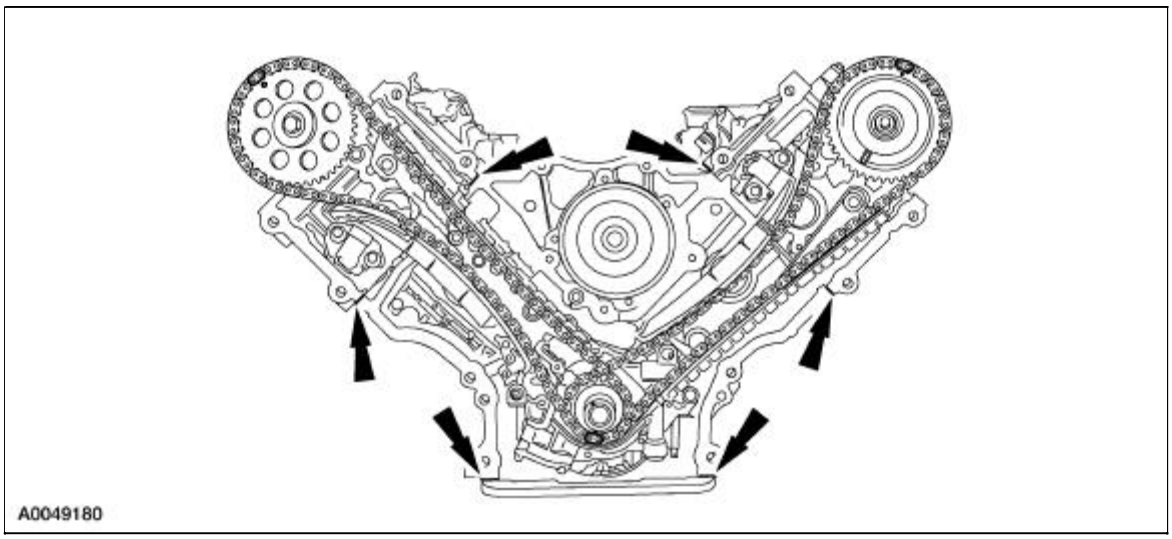


24. Install the crankshaft sensor ring on the crankshaft.

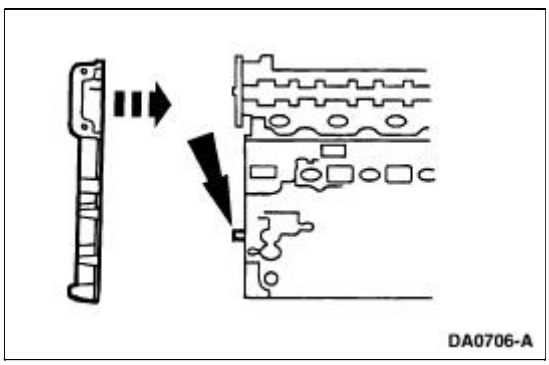


25. **NOTE:** If the engine front cover is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

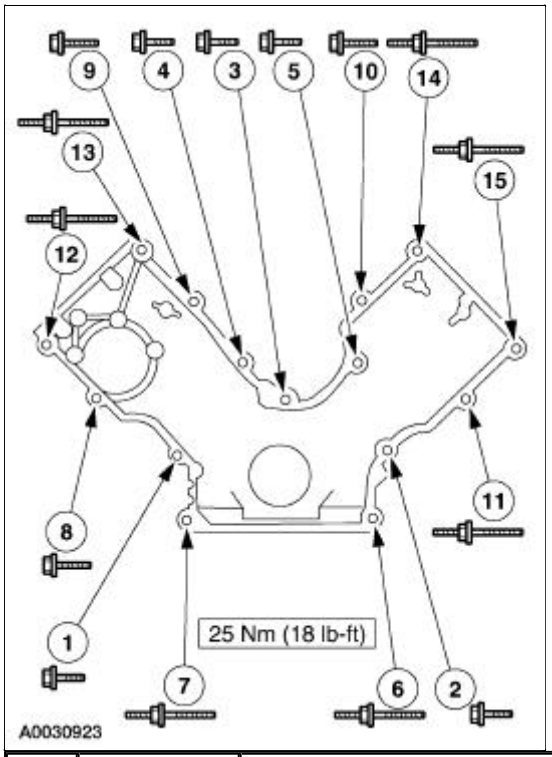
    Apply a bead of sealant along the head-to-block surface as shown.



26. Install a new engine front cover gasket on the engine front cover. Position the engine front cover. Install the fasteners finger-tight.



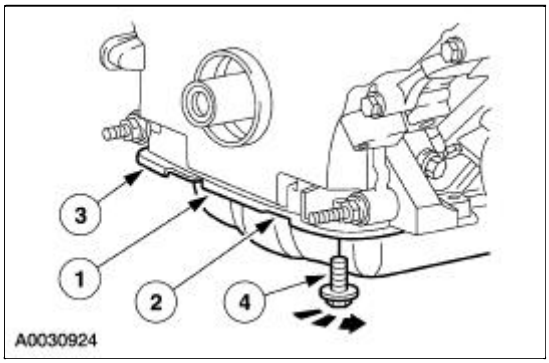
27. Tighten the front cover fasteners in the sequence shown.



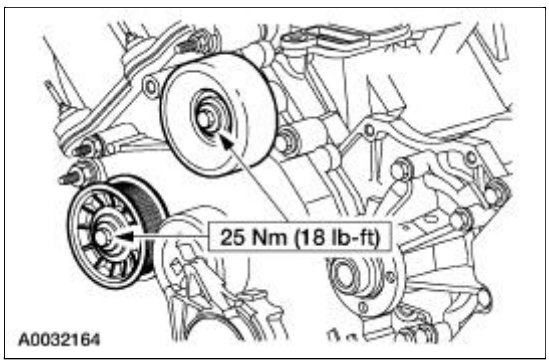
Item	Part Number	Description
1	N806177	Bolt, hex flange head pilot, M8 x 1.25 x 53
2	N806177	Bolt, hex flange head pilot, M8 x 1.25 x 53
3	N806177	Bolt, hex flange head pilot, M8 x 1.25 x 53
4	N806177	Bolt, hex flange head pilot, M8 x 1.25 x 53
5	N806177	Bolt, hex flange head pilot, M8 x 1.25 x 53
6	W706508	Stud, hex shldr pilot, M8 x 1.25 x 50 — m6 x 1 x 10
7	N808586	Stud and washer, hex head pilot, M8 x 1.25 x 60 — m6 x 1 x 26
8	N806177	Bolt, hex flange head pilot, M8 x 1.25 x 53
9	N806177	Bolt, hex flange head pilot, M8 x 1.25 x 53
10	N806177	Bolt, hex flange head pilot, M8 x 1.25 x 53
11	N806300	Stud, hex shldr pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26
12	W706560	Stud and washer, hex-head pilot, M8 x 1.25 x 65 — M8 x 1.25 x 16
13	N806300	Stud, hex shldr pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26
14	N806300	Stud, hex shldr pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26
15	N806300	Stud, hex shldr pilot, M8 x 1.25 x 65 — M8 x 1.25 x 26

28. Loosely install the bolts, then tighten the bolts in three stages in the sequence shown.
    - Stage 1: Tighten to 2 Nm (18 lb-in).
    - Stage 2: Tighten to 20 Nm (15 lb-ft).

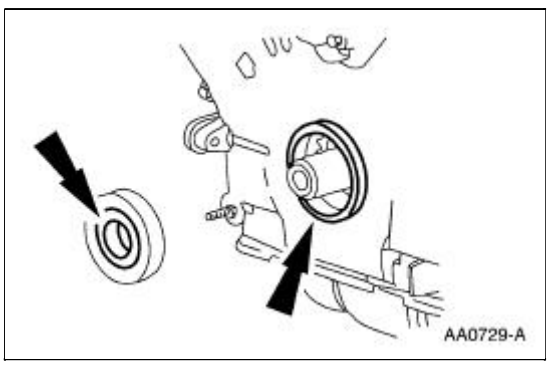
- Stage 3: Tighten an additional 60 degrees.



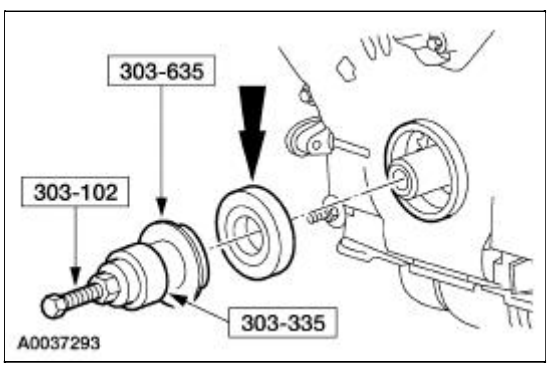
29. Install the belt idler pulleys.



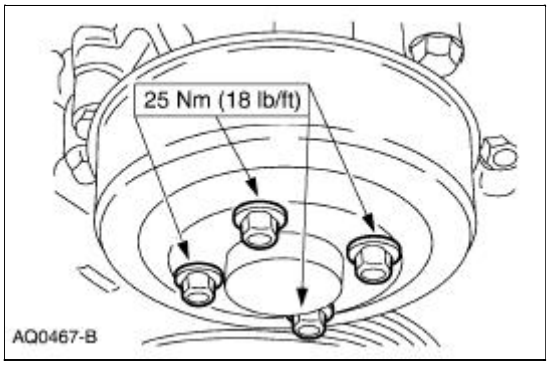
30. Lubricate the engine front cover and the front oil seal inner lip with clean engine oil.



31. Using the special tool, install the front oil seal.

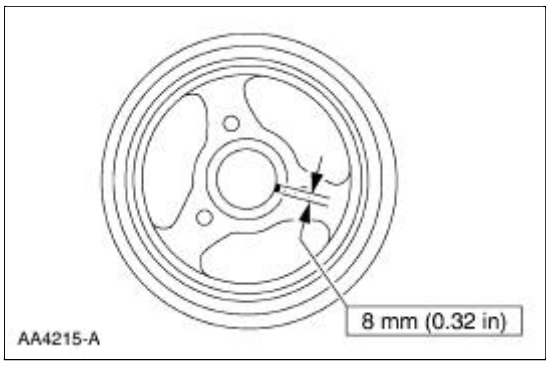


32. Install the coolant pump pulley and bolts.

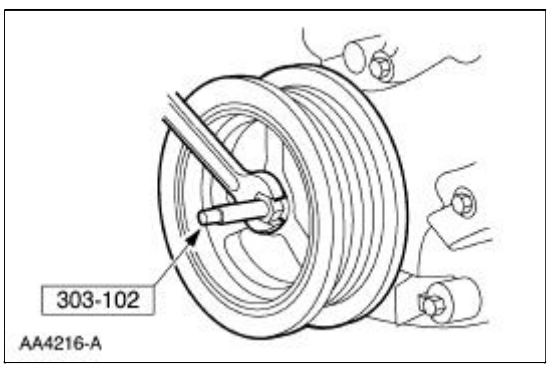


33. **NOTE:** The crankshaft pulley must be installed within four minutes of applying the sealant.

    Apply silicone gasket and sealant to the Woodruff key slot on the crankshaft pulley.



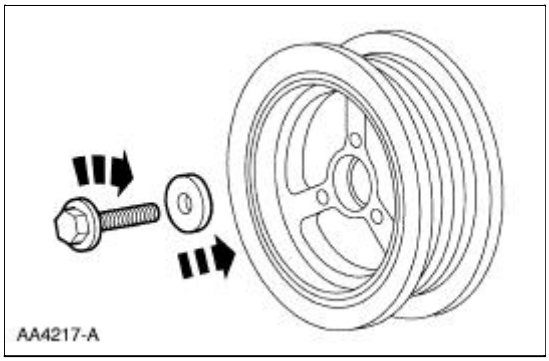
34. Using the special tool, install the crankshaft pulley.



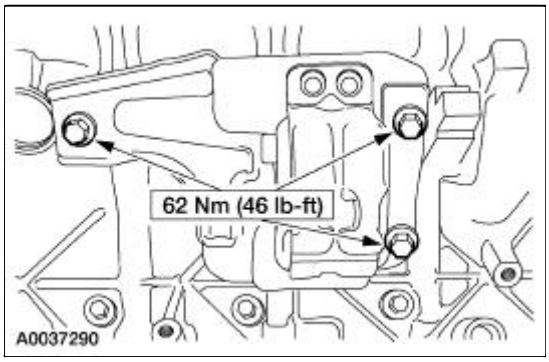
35. **NOTE:** Use special tool 303-009 or a suitable strap wrench to hold the crankshaft pulley.

    Install the washer and the bolt. Tighten the bolt in four stages.

    - Stage 1: Tighten to 90 Nm (66 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten to 50 Nm (37 lb-ft).
    - Stage 4: Tighten an additional 90 degrees.



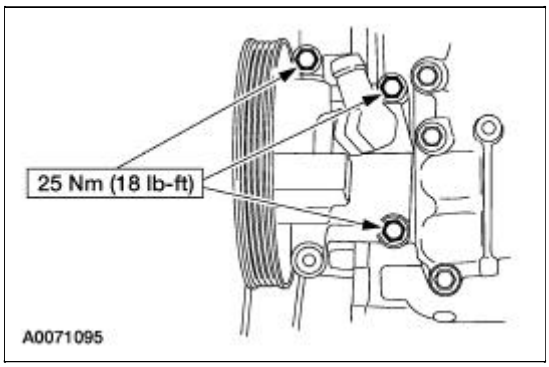
36. Install the RH engine mount.



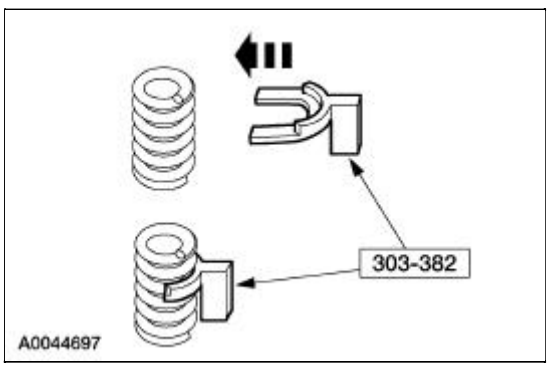
37. **NOTE:** Only three bolts are required for installation.

    Install the power steering pump bolts.

    - Position the power steering pump.
    - Install the bolts.



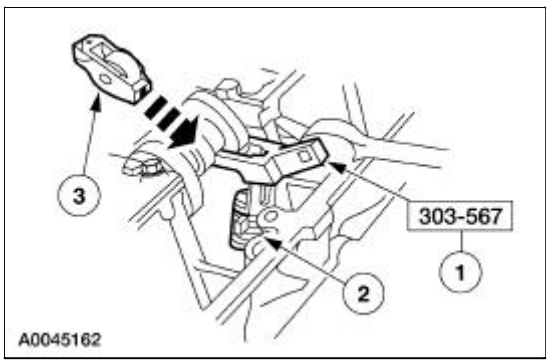
38. Install the special tool between the valve spring coils to prevent valve stem seal damage.



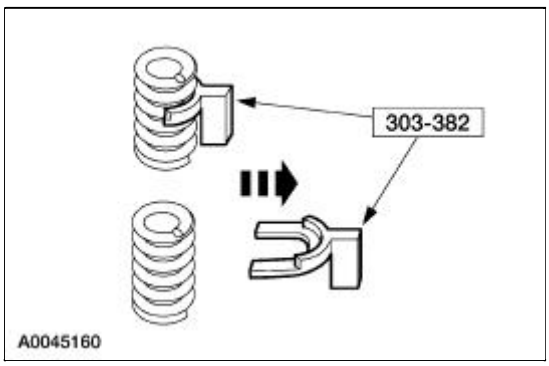
39. **NOTE:** Lubricate the camshaft roller followers using clean engine oil.

    NOTE: Position the cam lobe away from the camshaft roller follower location prior to installing each camshaft roller follower.

    Install the camshaft roller followers.
    1. Install the special tool.
    2. Compress the valve spring.
    3. Install the camshaft roller followers in their original locations.

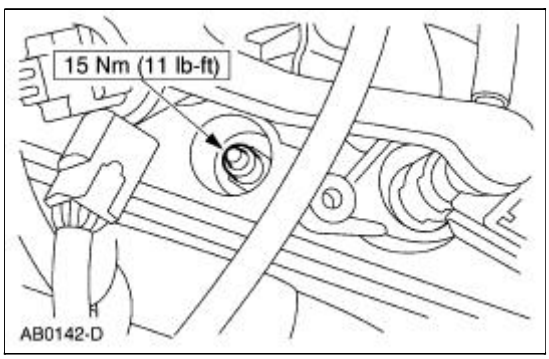


40. Remove the special tool.



41. **NOTE:** One spark plug shown, others similar.

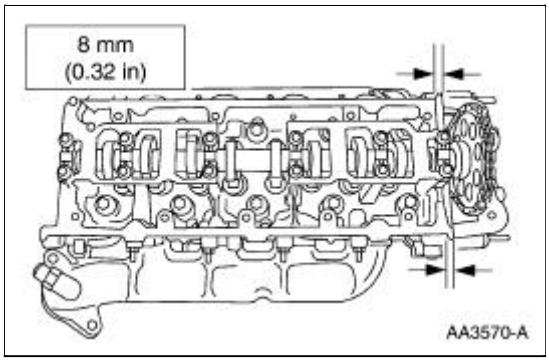
    Install the spark plugs.



42. **NOTE:** RH side shown, LH side similar.

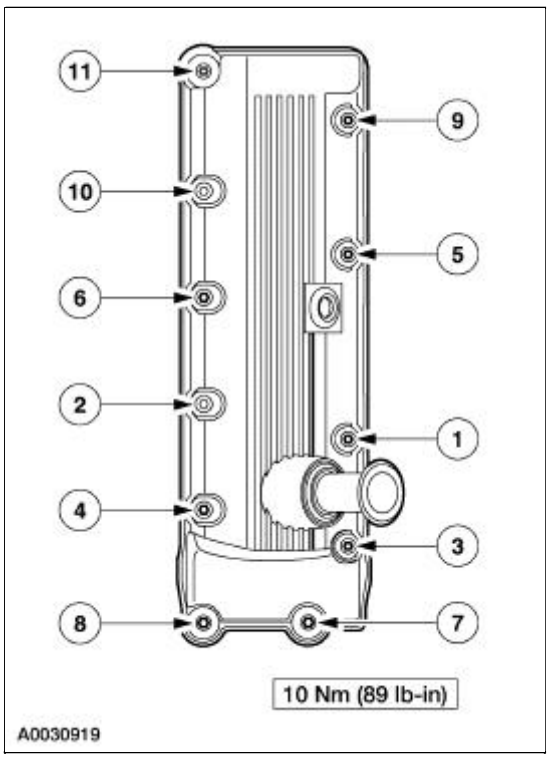
    NOTE: If not secured within four minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use silicone gasket remover and metal surface prep. Follow the directions on the packaging. Failure to follow this procedure can cause future oil leakage.

    Apply silicone gasket and sealant in the locations shown.



43. **NOTE:** RH valve cover shown, LH similar.

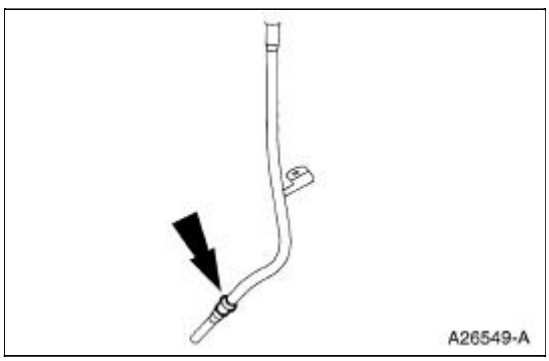
    Install the valve covers.



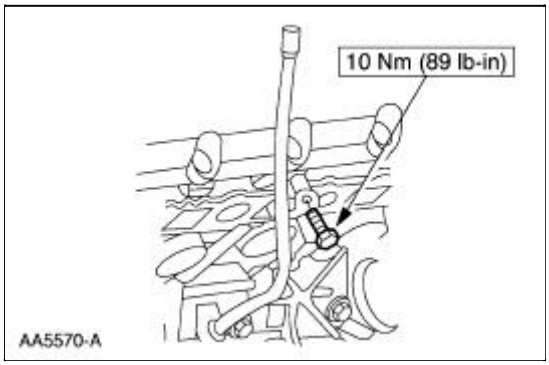
LH cylinder head

44. **NOTE:** Lubricate the O-ring seal with clean engine oil.

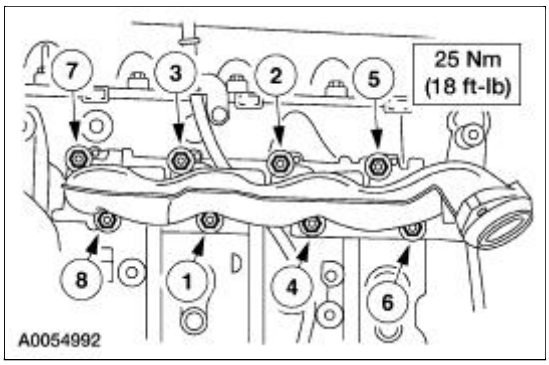
    Install a new O-ring.



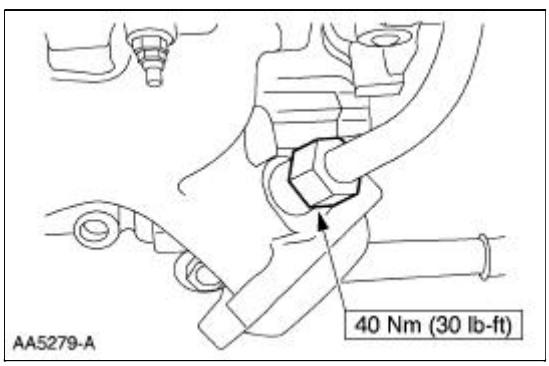
45. Install the oil level indicator tube.



46. Install the LH exhaust manifold.
    - Install a new manifold gasket.
    - Install the LH exhaust manifold.
    - Tighten the nuts in the sequence shown.

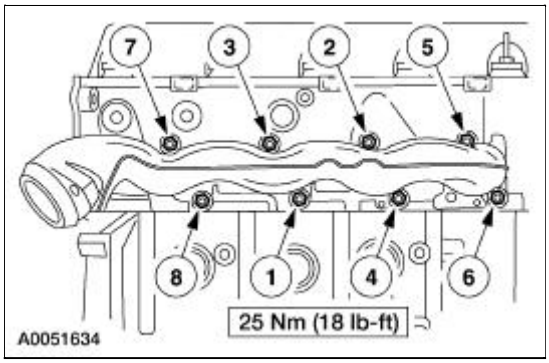


47. Connect the lower end of the exhaust gas recirculation (EGR) tube to the LH exhaust manifold.



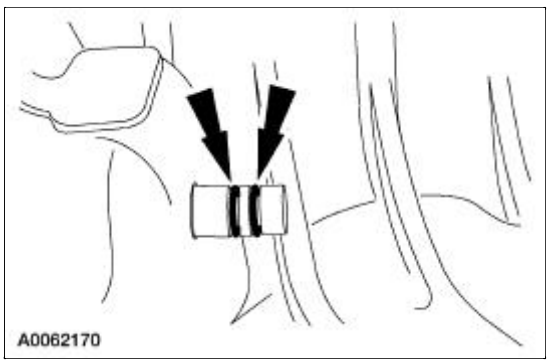
RH cylinder head

48. Install the RH exhaust manifold.
    - Install a new exhaust manifold gasket.
    - Install the RH exhaust manifold.
    - Tighten the nuts in the sequence shown.

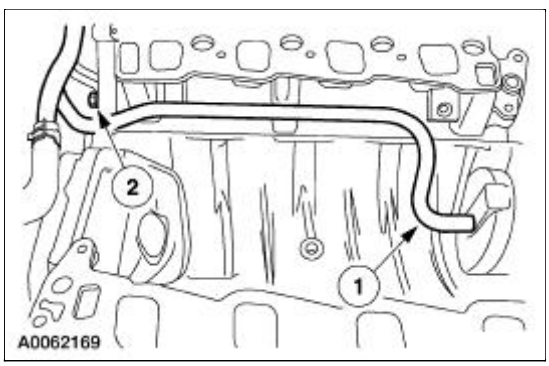


Both cylinder heads

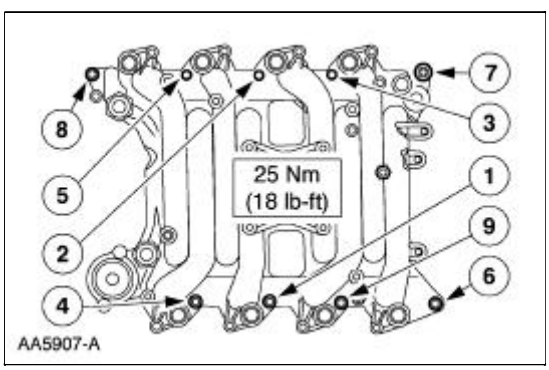
49. Inspect O-ring seals and install new O-ring seals as necessary.



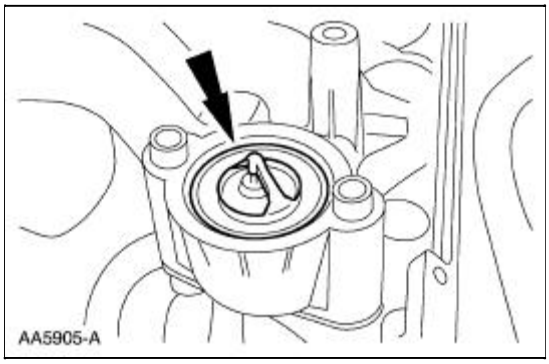
50. Install the coolant bypass tube.
    1. Install the bypass tube.
    2. Install the nut.



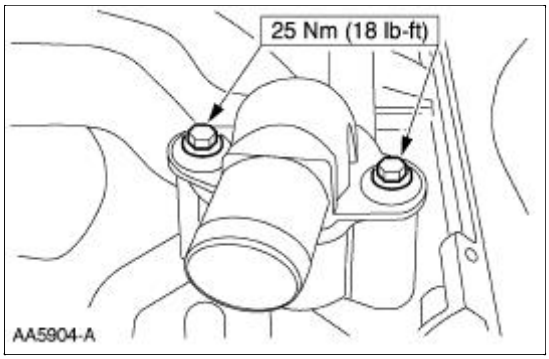
51. Install the intake manifold and gaskets. Tighten the bolts in the sequence shown.



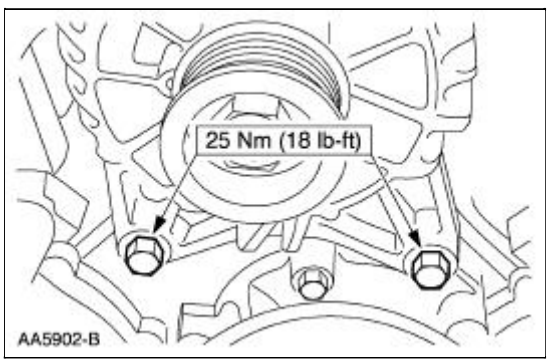
52. Install the thermostat and O-ring.
    - Install a new O-ring as necessary.



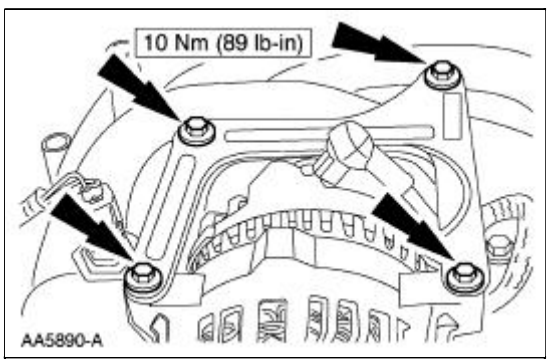
53. Install the coolant outlet adapter.



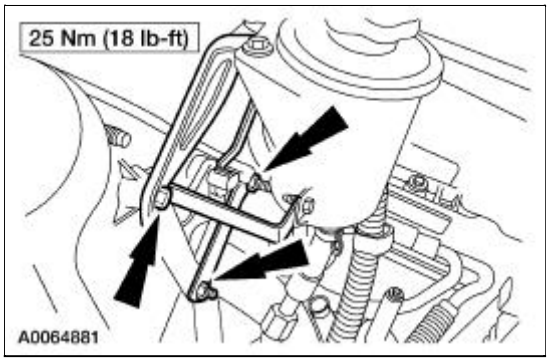
54. Install the bolts and the generator.



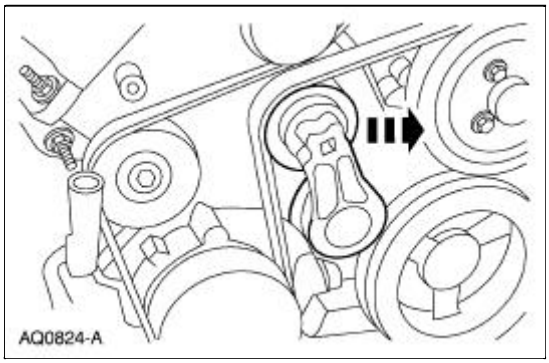
55. Install the upper generator support bracket.



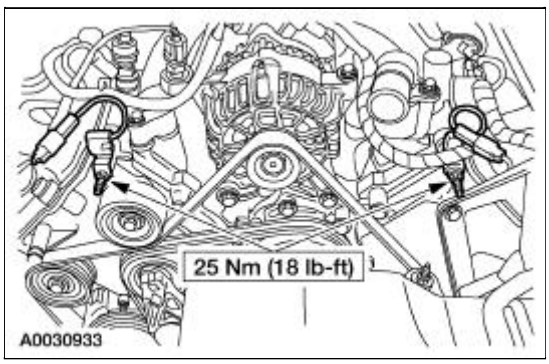
56. Position the power steering reservoir and bracket, then install the bolts.



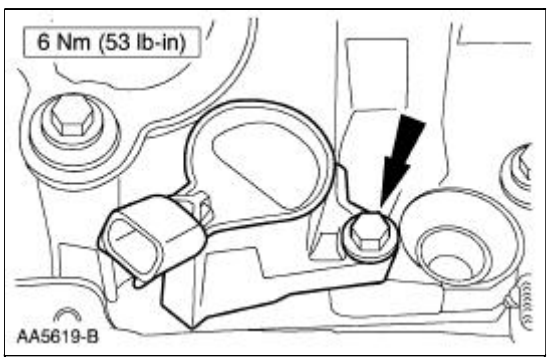
57. Install the accessory drive belt.



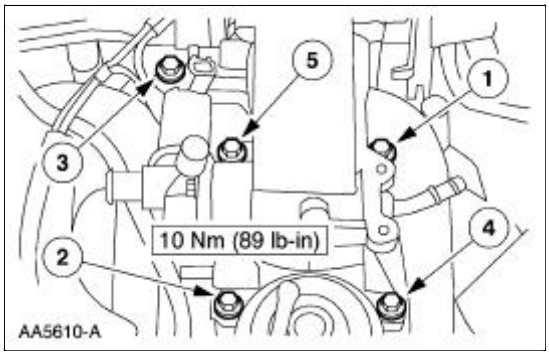
58. Install the radio interference capacitors.



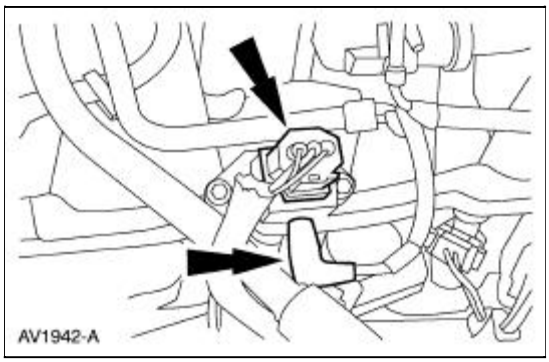
59. Install the ignition coils and bolts.



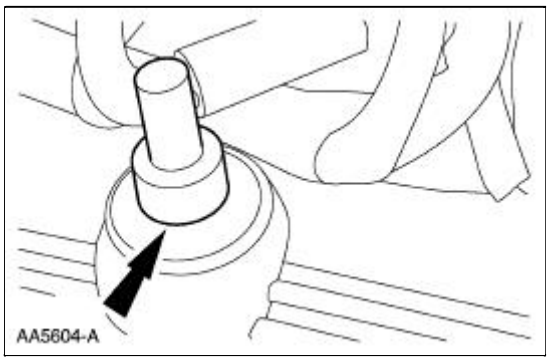
60. Position the throttle body and install the bolts, tightening in the sequence shown.



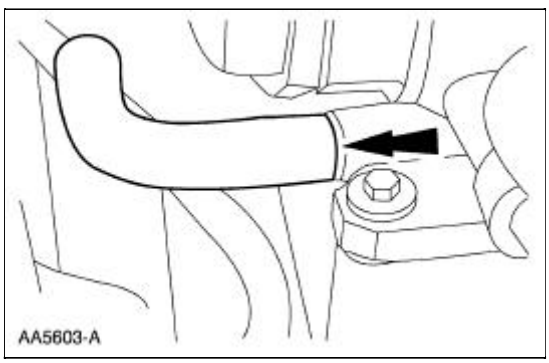
61. Connect the vacuum line to the fuel pressure sensor.



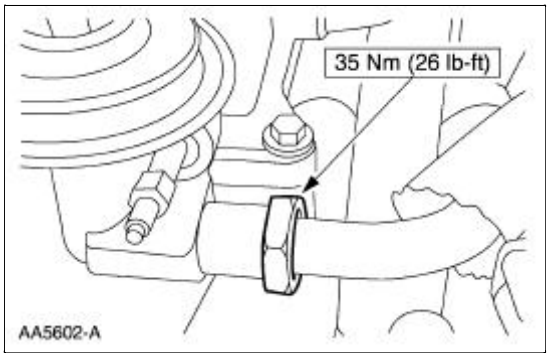
62. Install the positive crankcase ventilation (PCV) valve and hose as an assembly.



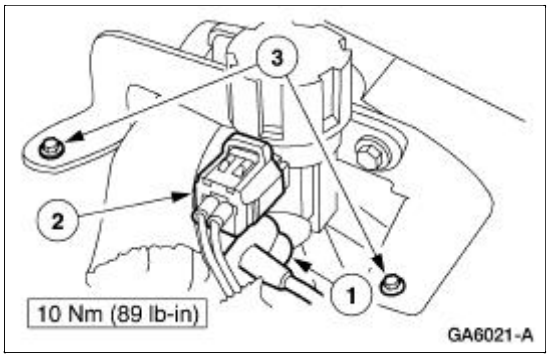
63. Connect the PCV hose to the base of the throttle body.



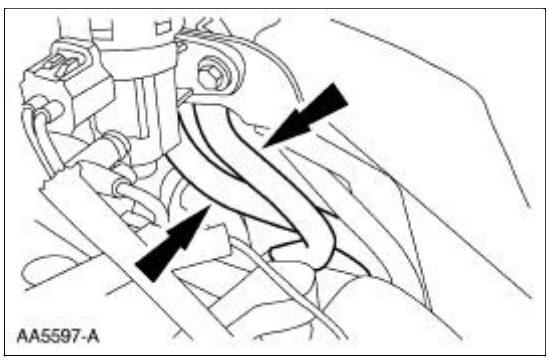
64. Connect the EGR tube to the EGR valve.



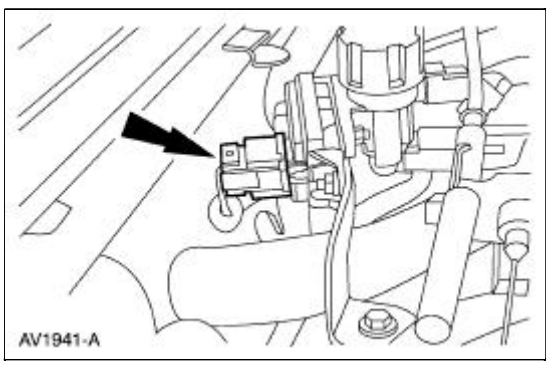
65. Install the EGR vacuum regulator solenoid.
    1. Install the vacuum lines.
    2. Install the electrical connector.
    3. Install the bolts.



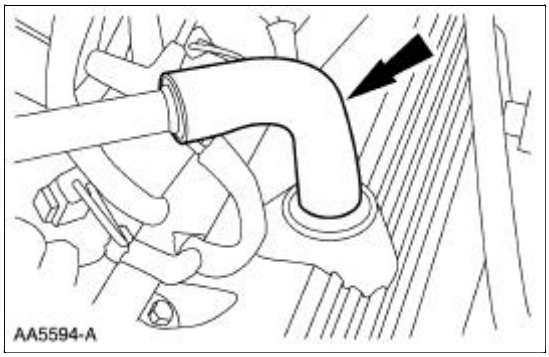
66. Connect the hoses from the differential pressure feedback EGR transducer.



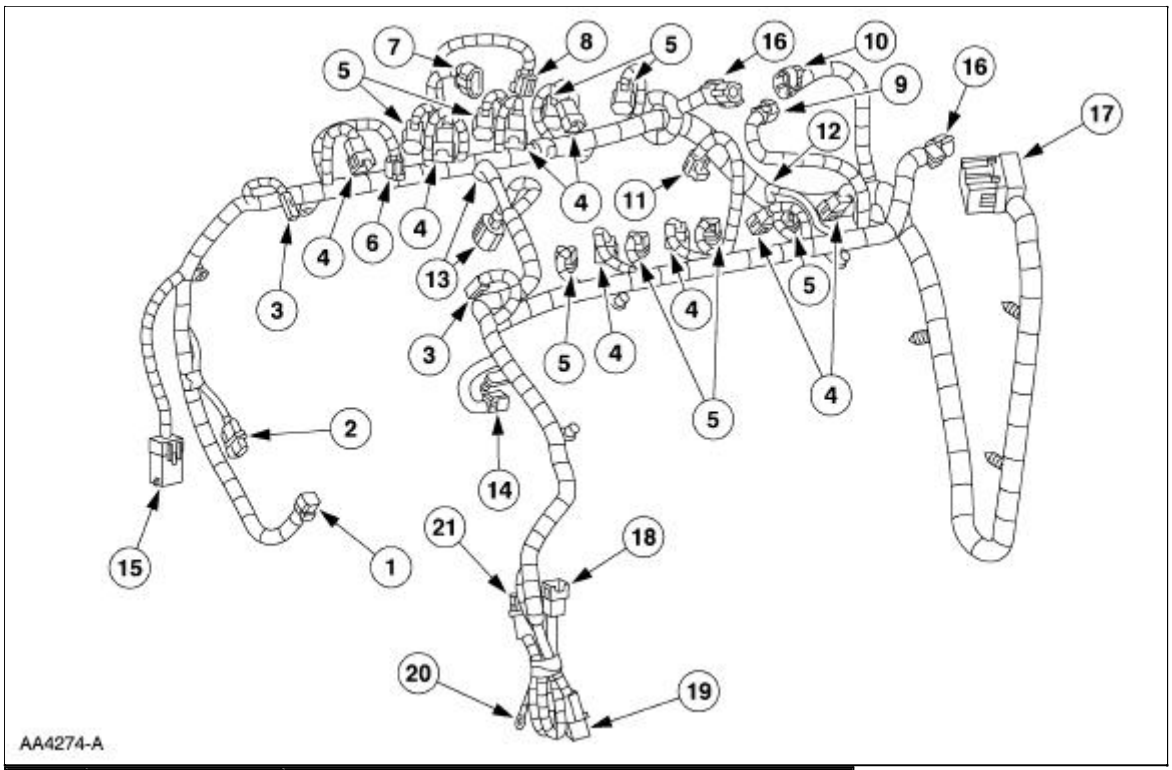
67. Connect the differential pressure feedback EGR electrical connector.



68. Install the breather tube.



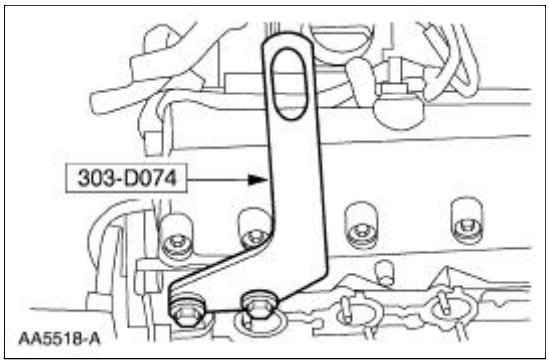
69. Install the engine control sensor wiring.



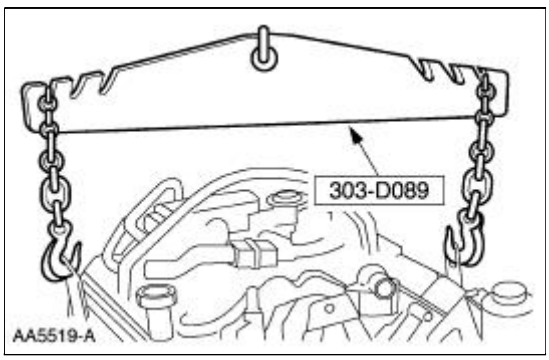
Item	Part Number	Description
1	—	To crankshaft position sensor
2	—	To A/C compressor
3	—	To radio ignition interference capacitor (2)
4	—	To fuel injectors (8)
5	—	To ignition coils (8)
6	—	To engine coolant temperature sensor
7	—	To throttle position sensor
8	—	To idle air control valve
9	—	To EGR vacuum regulator
10	—	To differential pressure feedback EGR
11	—	To fuel pressure regulator
12	—	Fuel injection ground
13	—	To generator
14	—	To camshaft position sensor

15	—	To body
16	—	To heated oxygen sensor (2)
17	—	Engine bulkhead connector
18	—	To low coolant sensor
19	—	To body
20	—	To power distribution box
21	—	To body

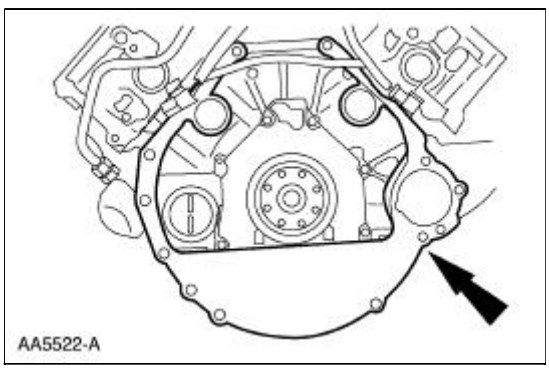
70. Install the RH and LH special tool.



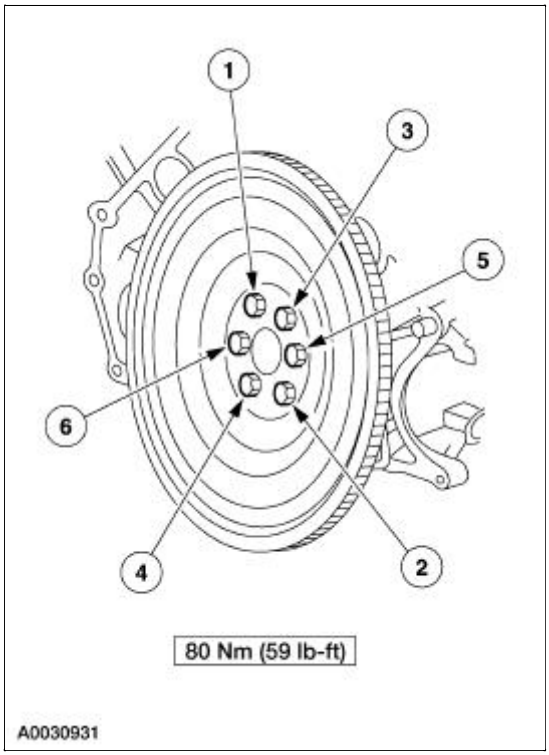
71. Using the special tool, remove the engine from the stand.



72. Install the separator plate.



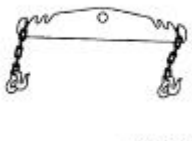
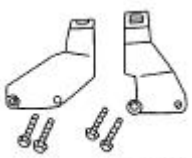
73. Install the flywheel.



74. Install the engine. For additional information, refer to Engine in the Installation portion of this section.

Engine

Special Tool(s)

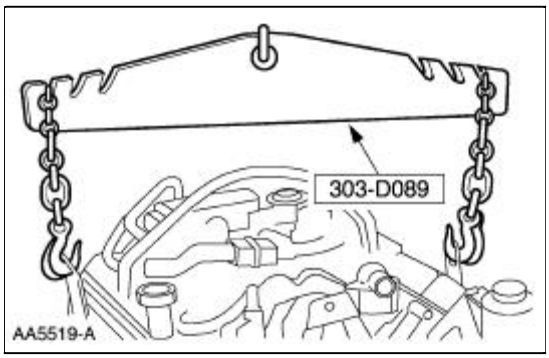
 ST1602-A	Spreader Bar 303-D089 (D93P-6001-A3)
ST2334-A	Support Bracket, Engine 303-639
ST1604-A	Lifting Bracket, Engine 303-D087 (D93P-6001-A1)
ST1603-A	Lifting Bracket, Engine 303-D088 (D93P-6001-A2)
 ST1701-A	Lifting Bracket Set, Engine 303-D074 (D91P-6001-A)

Material

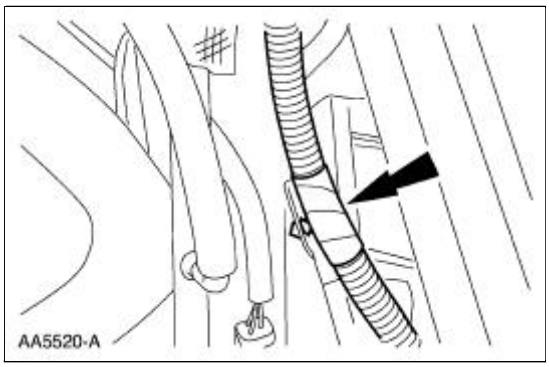
Item	Specification
Metal Surface Cleaner F4AZ-19A536-RA or equivalent	WSE-M5B392-A
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4
Super Premium SAE 5W-20 Engine Oil XO-5W20-QSP or equivalent	WSS-M2C153-H
Premium Engine Coolant E2FZ-19549-AA (In Canada CXC-10; In Oregon F5FZ-19549-CC) or equivalent	ESE-M97B44-A

1. **NOTE:** Adjust the transmission support jack as necessary to aid in the installation of the engine.

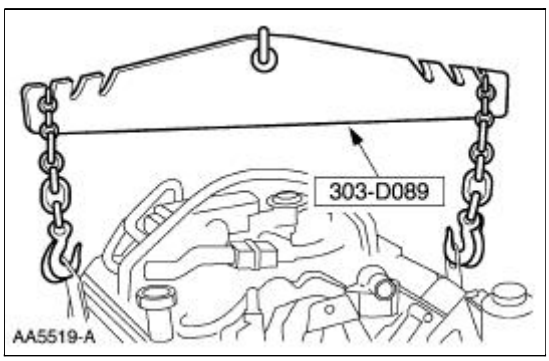
   Using the special tool, install the engine.



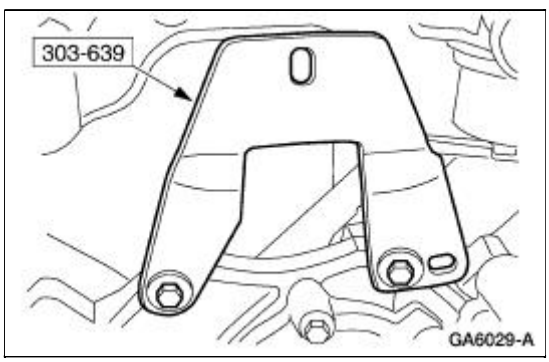
2. Connect the transmission wiring to the bracket during installation.



3. Remove the special tool.

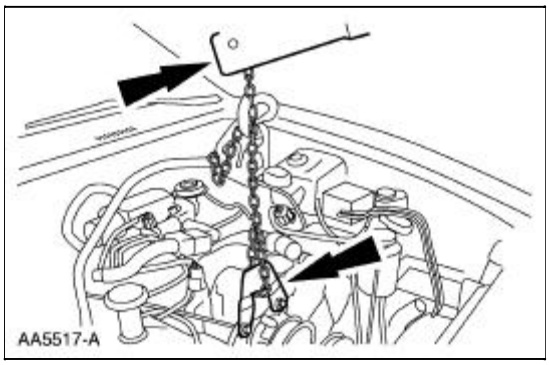


4. Install the special tool.

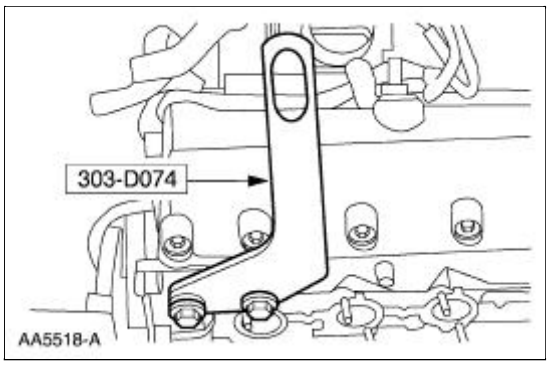


5. **NOTE:** This step will allow the installation of the exhaust manifold through the bottom and access for the removal of the engine lift brackets.

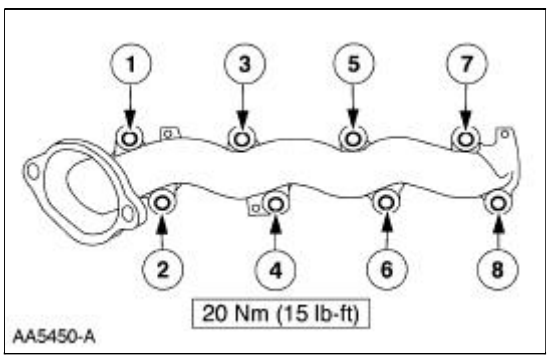
   Using a suitable floor crane raise the engine.



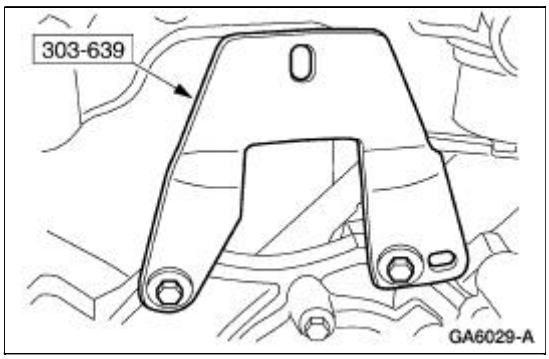
6. Remove the RH and LH special tool.



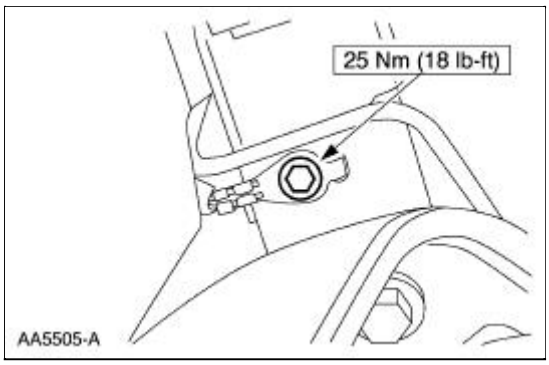
7. Install new gaskets and the exhaust manifolds, tighten the nuts in the sequence shown.



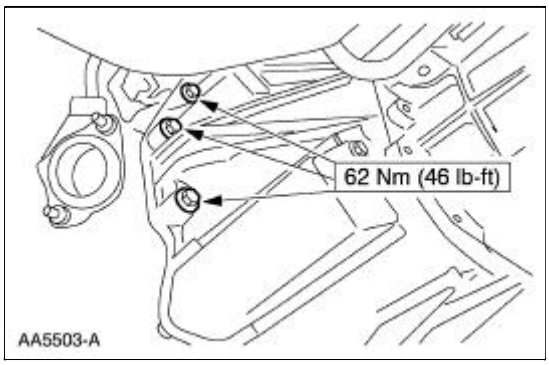
8. Lower the engine, remove the special tool.



9. Install the generator. For additional information, refer to Section 414-02 .
10. Raise the vehicle. for additional information, refer to Section 100-02 .
11. Install the power steering pump. For additional information, refer to Section 211-02 .
12. Install the bolt and the body ground.

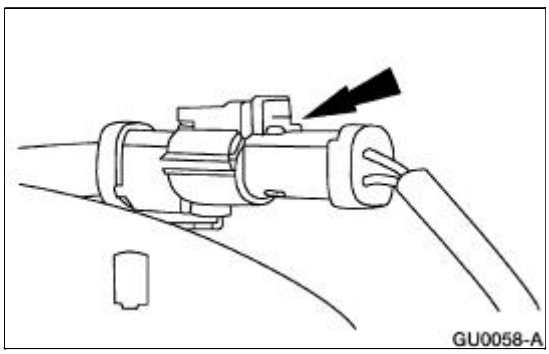


13. Install the nine bell housing bolts.



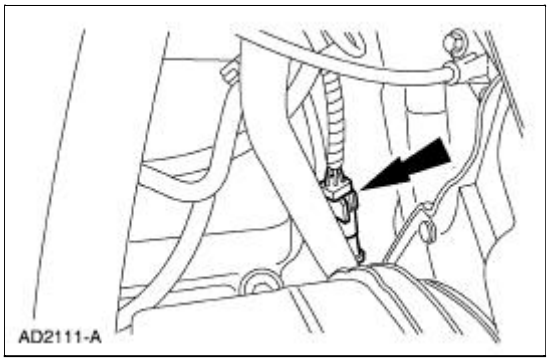
14. Install the starter. For additional information, refer to Section 303-06 .
15. **NOTE:** This will need to be done as the H-pipe is being positioned.

    Connect the LH heated oxygen sensor.

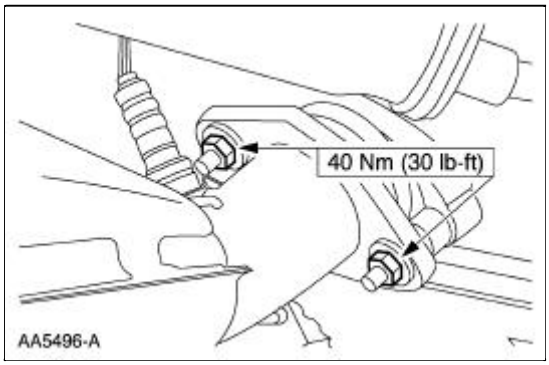


16. **NOTE:** This will need to be done as the H-pipe is being positioned.

    Connect the RH heated oxygen sensor.



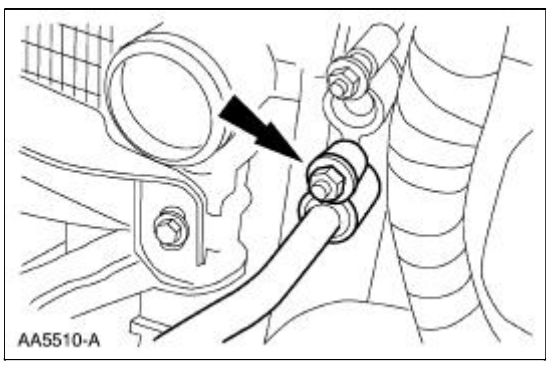
17. Re-position the H-pipe and install the four exhaust flange to manifold nuts.



18. Lower the vehicle.

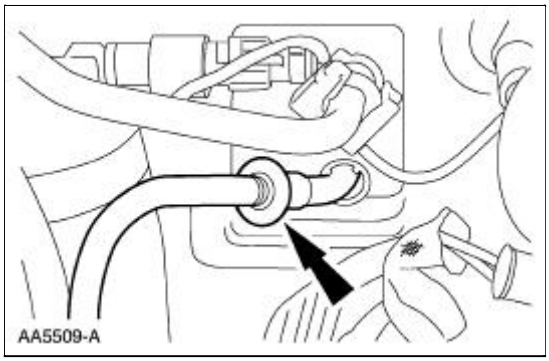
19. **NOTE:** The O-ring seal must be inspected and cleaned before installation. For additional information, refer to Section 412-00 .

    Install the A/C line and tighten the nut.

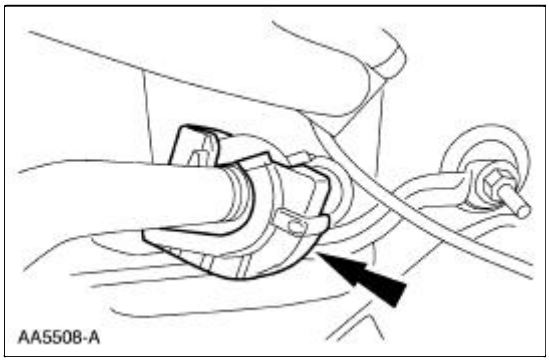


20. **NOTE:** The O-ring seal must be inspected and cleaned before installation. For additional information, refer to Section 412-00 .

    Connect the line to the evaporator core.

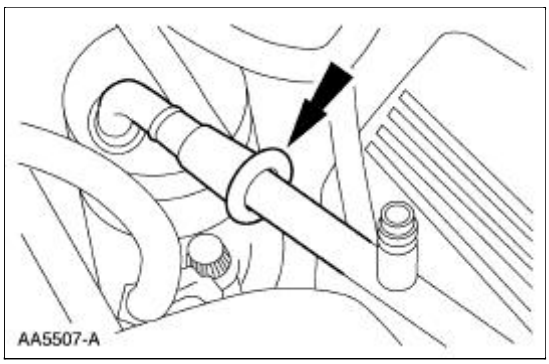


21. Install the safety clip.

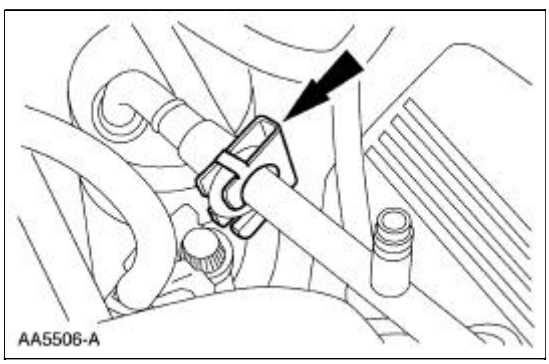


22. **NOTE:** The O-ring seal must be inspected and cleaned before installation. For additional information, refer to Section 412-00 .

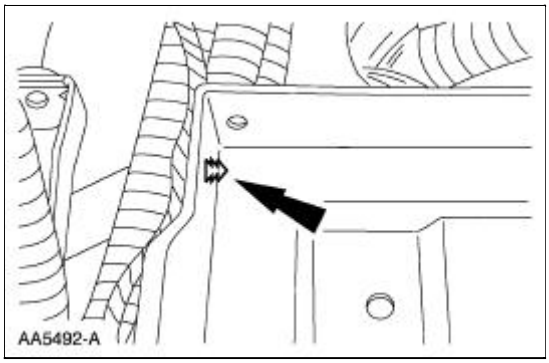
    Connect the line to the receiver drier.



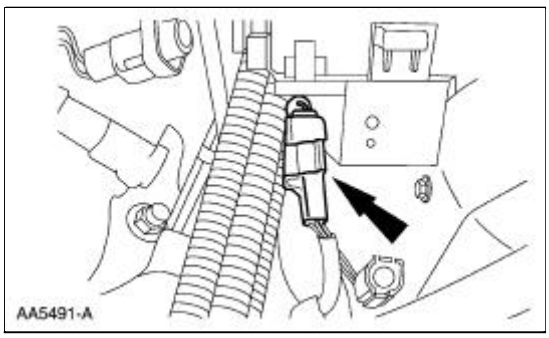
23. Install the safety clip.



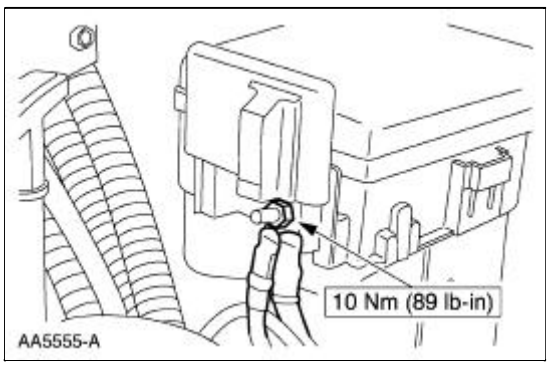
24. Connect the degas sensor lead to the battery tray.



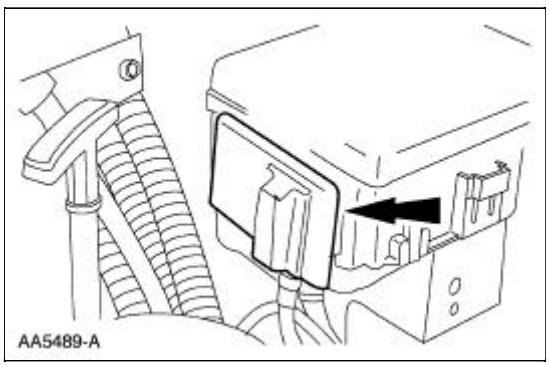
25. Connect the connector.



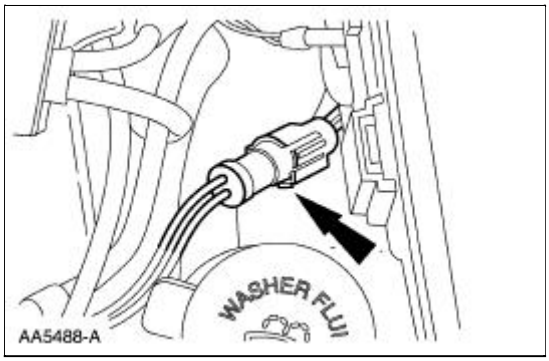
26. Install the battery leads.



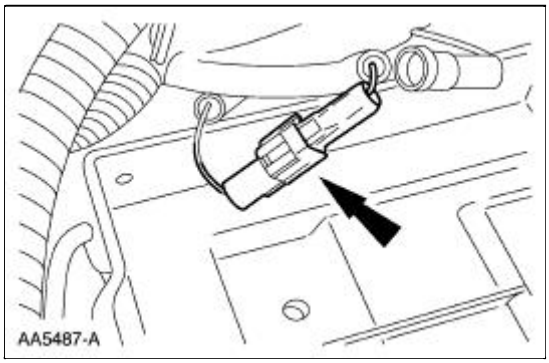
27. Position the access cover.



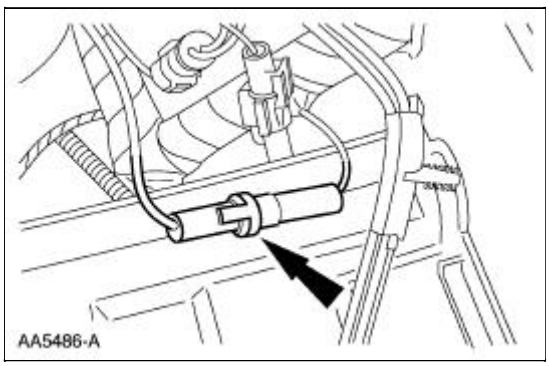
28. Connect the ground connector.



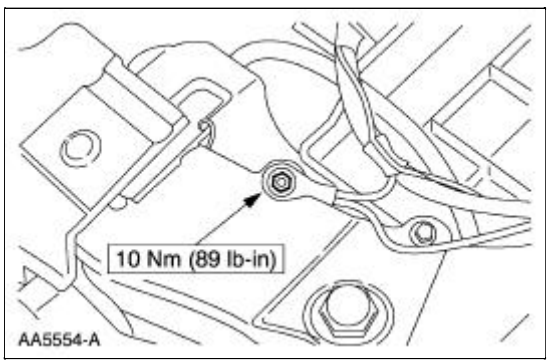
29. Connect the connector.



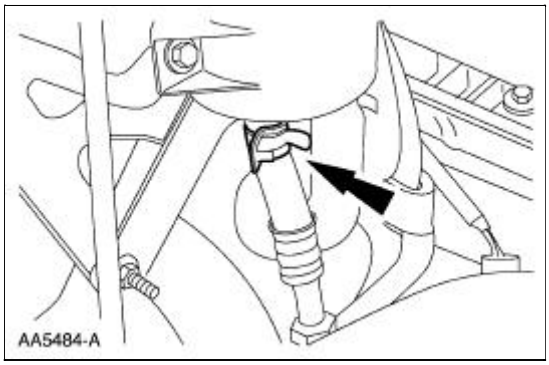
30. Connect the fuse link.



31. Install and tighten the body ground.

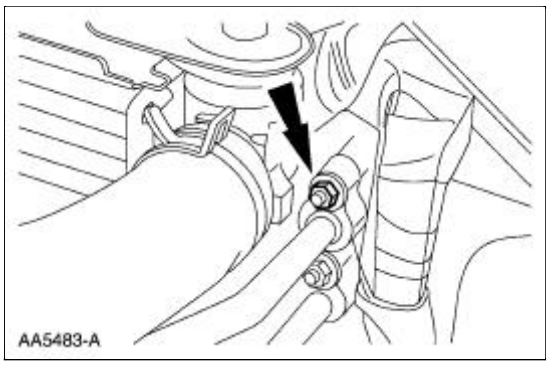


32. Connect the power steering line.

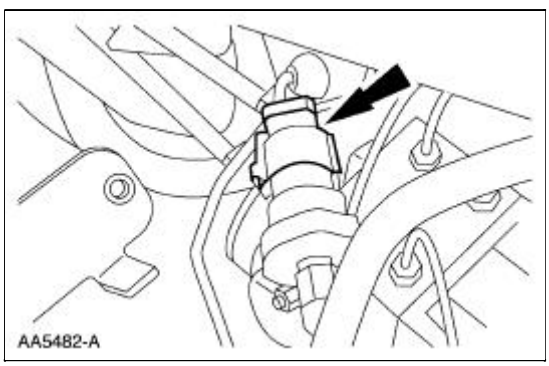


33. **NOTE:** The O-ring seal must be inspected and cleaned before installation. For additional information, refer to Section 412-00 .

    Install the A/C line.

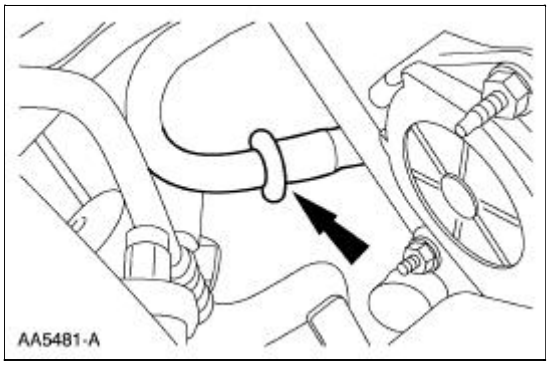


34. Connect the A/C pressure cycle switch.

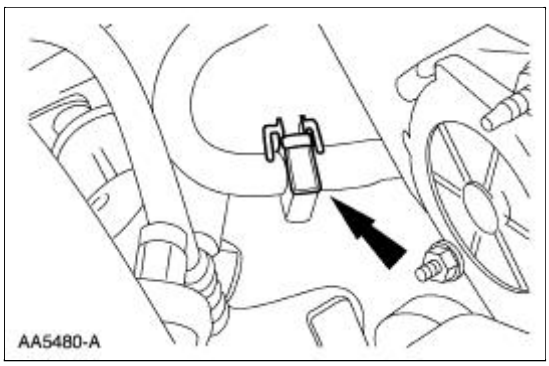


35. **NOTE:** The O-ring seal must be inspected and cleaned before installation. For additional information, refer to Section 412-00 .

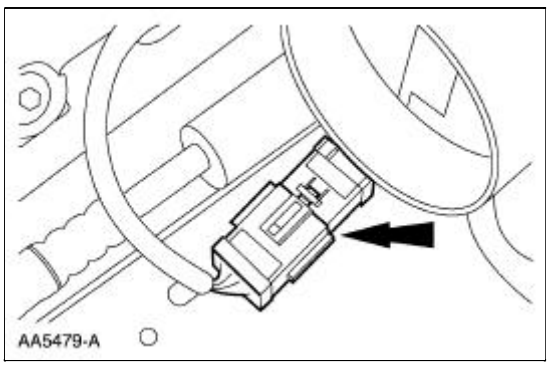
    Connect the A/C manifold suction line.



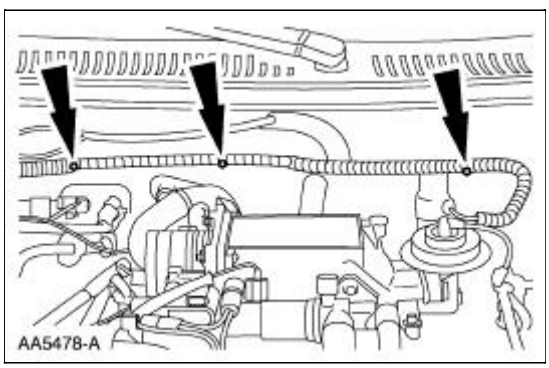
36. Install the safety clip to the manifold suction line.



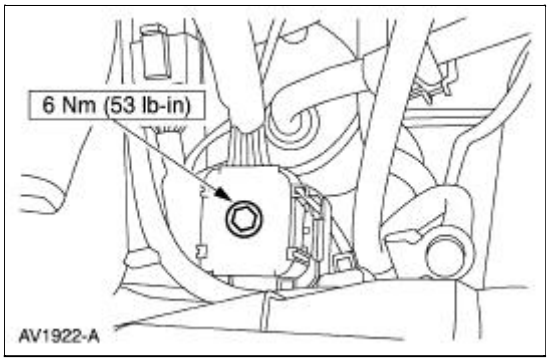
37. Connect the electrical connector.



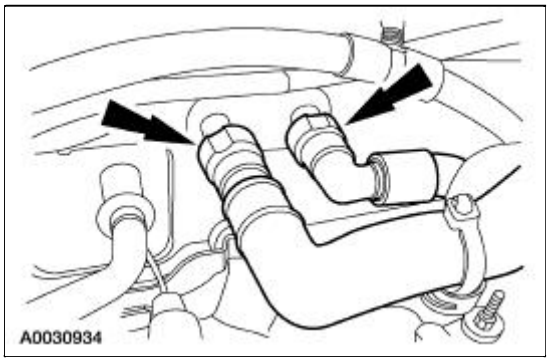
38. Connect the harness in three locations.



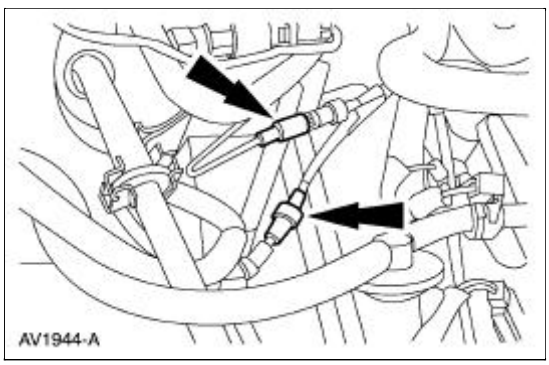
39. Connect the engine bulkhead connector.



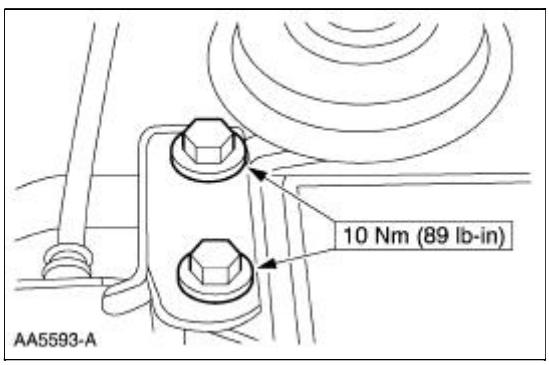
40. Connect the heater water hoses.



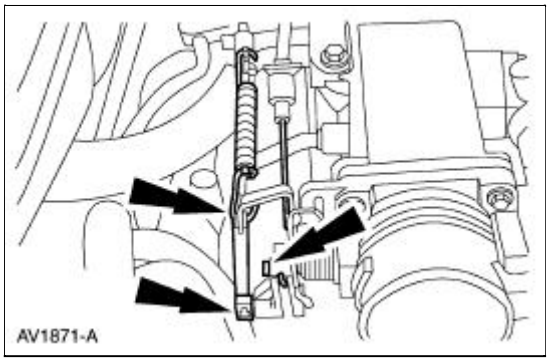
41. Connect the climate control vacuum supply lines.



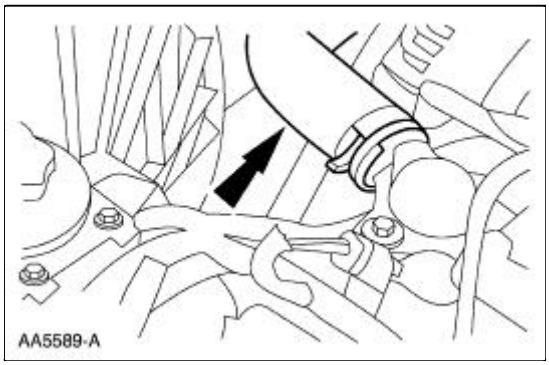
42. Position the cables and install the bracket.



43. Connect the throttle cable, speed control actuator cable and the return spring.



44. Connect the upper radiator hose from the water outlet adapter.



45. Connect the fuel lines. For additional information, refer to Section 310-00 .
46. Install the battery. For additional information, refer to Section 414-01 .
47. Install the air cleaner and outlet tube. For additional information, refer to Section 303-12 .
48. Install the degas bottle. For additional information, refer to Section 303-03A or Section 303-03B .
49. Fill the fluids to the correct levels.
50. Start the engine and check for leaks. Stop the engine and recheck the fluid levels.
51. Recharge the A/C system. For additional information, refer to Section 412-00 .
52. Install the hood.